
The HOW AND WHY Wonder Book of
ROCKETS AND MISSILES
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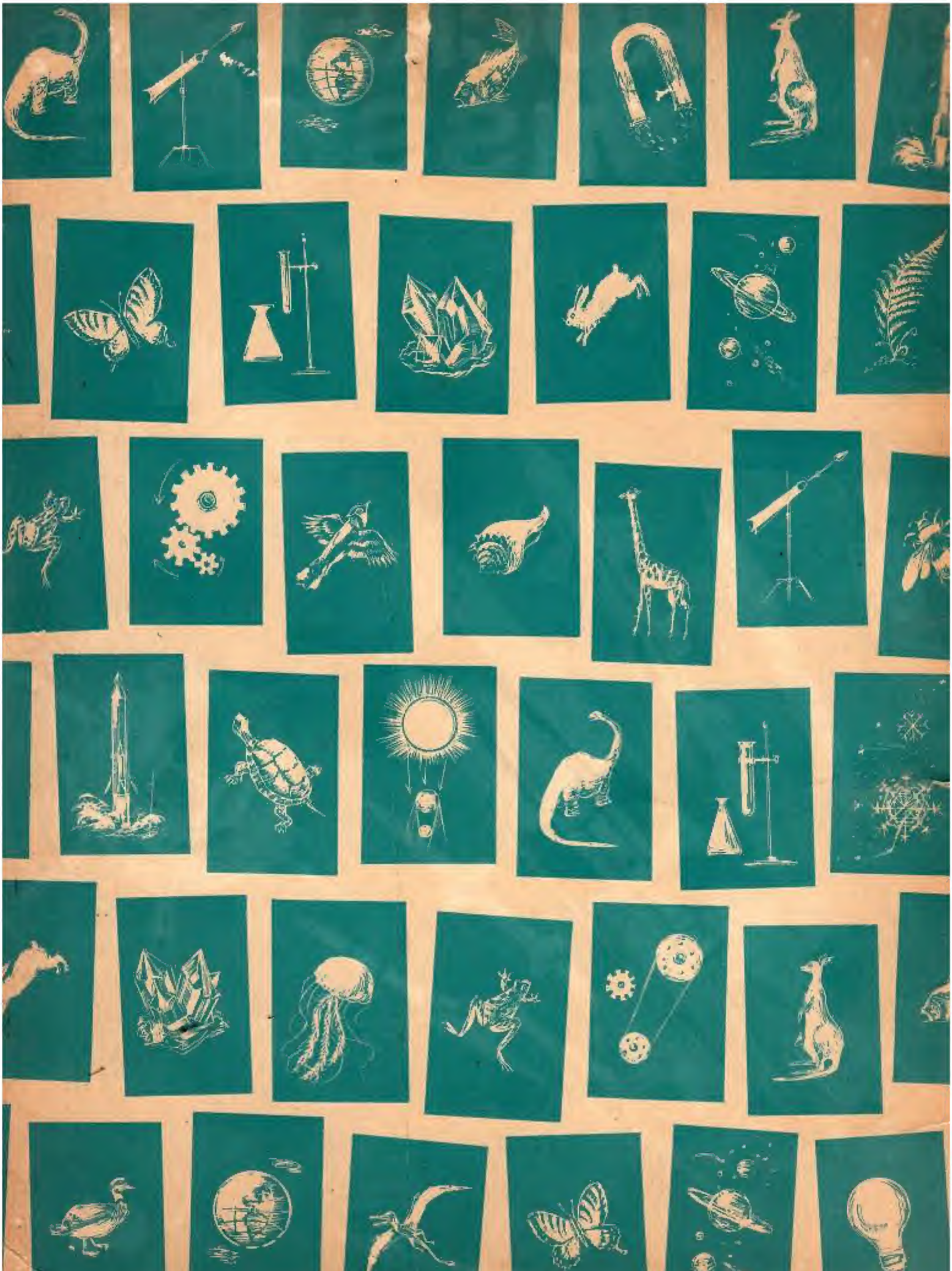
How and Why Wonder Books

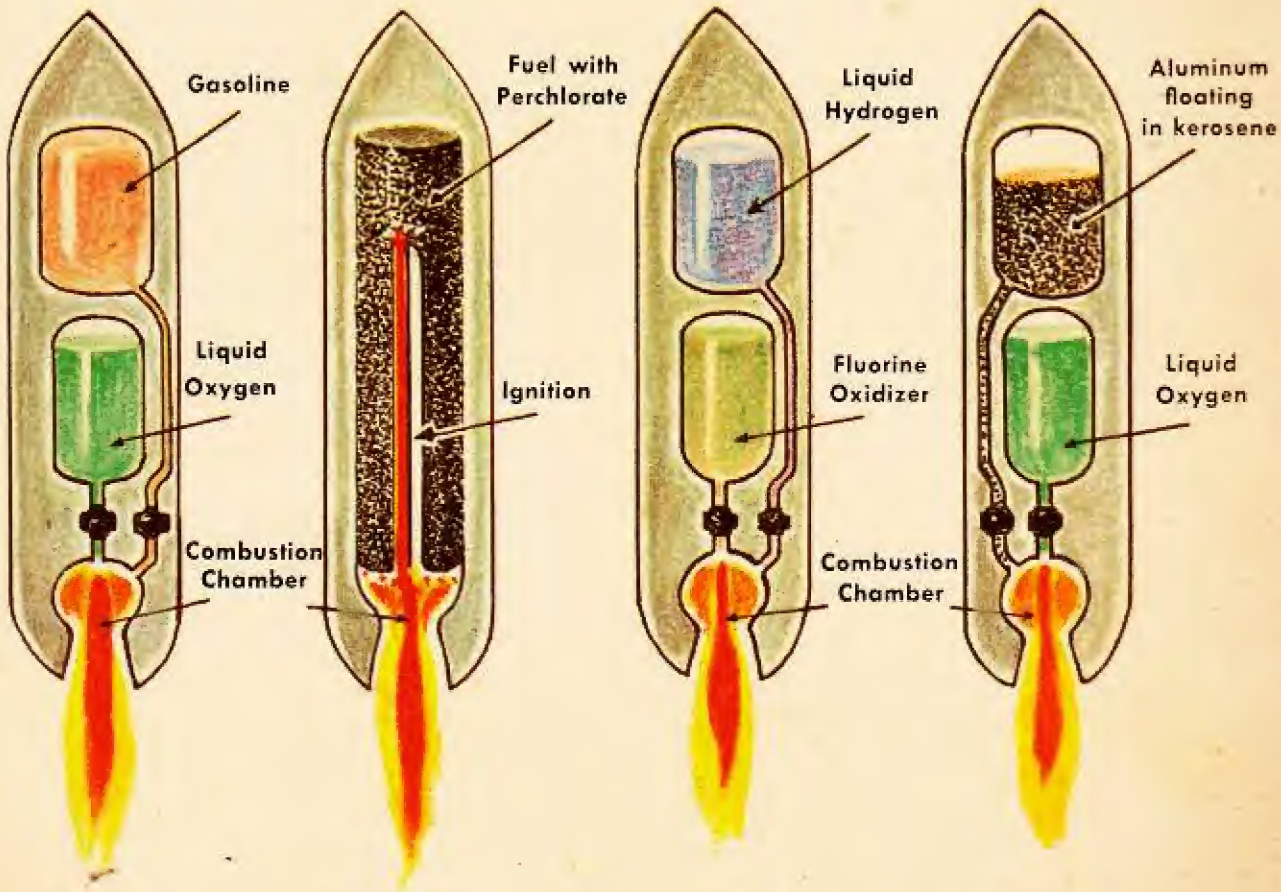


WHAT ARE THE DIFFERENT KINDS OF ROCKET FUELS?

THE only engine capable of operating in airless space is the rocket which needs no outside air for combustion. In place of atmosphere, the rocket must have an oxidizer to make the fuel burn — usually liquid oxygen, which must be kept at 272 degrees below zero, F., and must be handled carefully.

Rockets burning solid fuels demand less care, but the fuel combustion is more difficult to control.

The first rocket engines had moderate thrust — the one in the X-1 delivered 6,000 pounds — but the U. S. is now building engines with a thrust of over a million pounds. This is the stupendous force needed to put man into space and onto a celestial planet.



LIQUID FUEL

Specific Thrust: 264.
The liquid fuel flow is easy to control. The rocket design is complicated, and mechanical failures are apt to occur.

SOLID FUEL

Specific Thrust: Above 250.
Solid fuel is easily stored and handled, but fuel combustion is hard to control.

EXOTIC FUEL

Specific Thrust: 373.
Exotic fuel gives the rocket greater speed and larger load-carrying capacity, but is difficult to store and handle.

METAL FUEL

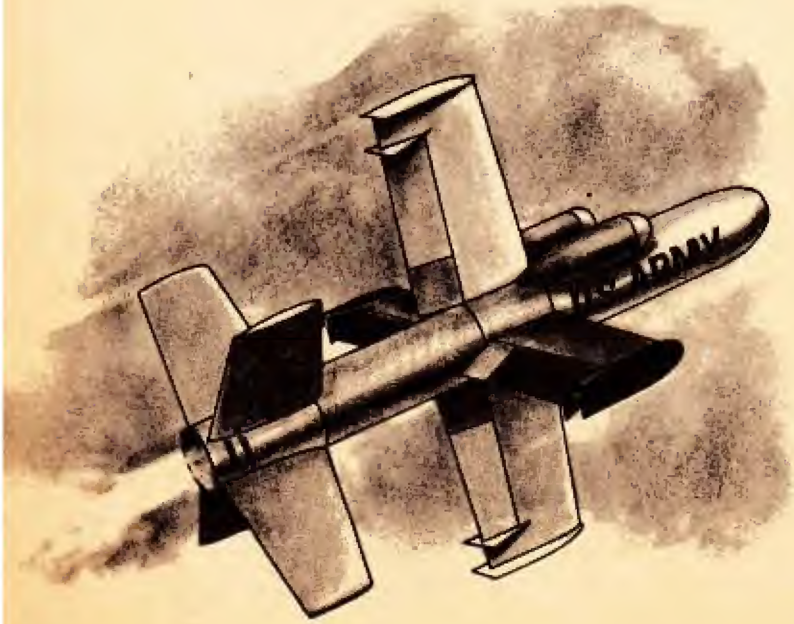
Specific Thrust: 325.
It is easily made and stored, but metal fuel is apt to clog pipelines. It is also hard to keep aluminum in suspension.

HOW DOES THE MODERN ARMY USE ROCKETS?

TO BE ready for battle under atomic war conditions, the modern army must have massive striking firepower that can be moved to the threatened areas with great rapidity.

The U. S. Army has developed a whole family of solid-fueled rockets mounted on mobile-launchers which have taken the place and exceeded the firepower of conventional artillery. Their range varies from rockets which can stop a tank at 2,000 yards, to 27-foot missiles that, guided by radio, can blast a target twenty miles away with a 1500-pound warhead. Because of the solid fuel, Army rocket missiles are more nearly trouble-free than those using liquid propellant and are easier for the crews to handle.

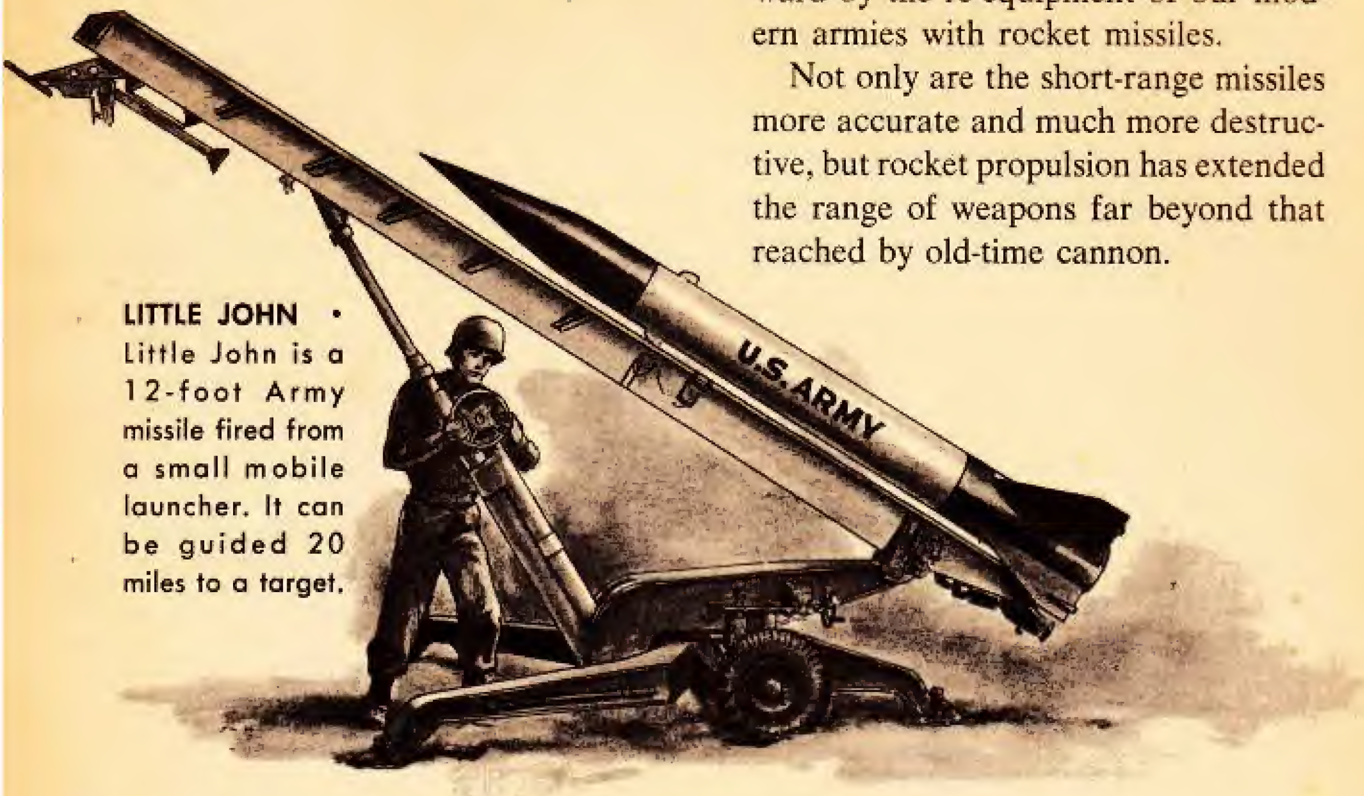
LACROSSE • Mounted on a mobile-launcher, the Lacrosse can hit and destroy enemy strong points up to 20 miles away. It is a solid-propellant missile easily handled by infantrymen, and can be guided accurately to its target by radio.



DART • This small but effective anti-tank rocket, with a range of over 2,000 yards, is used by infantry and armored combat units.

The change-over from the early days of horse-drawn guns used in World War I to the mechanized artillery of World War II is now being carried forward by the re-equipment of our modern armies with rocket missiles.

Not only are the short-range missiles more accurate and much more destructive, but rocket propulsion has extended the range of weapons far beyond that reached by old-time cannon.



LITTLE JOHN • Little John is a 12-foot Army missile fired from a small mobile launcher. It can be guided 20 miles to a target.

HONEST JOHN • Honest John is a 3-ton, 27-foot, solid-propellant missile with a range of about 30 miles.

WERE MANY ROCKETS FIRED IN WORLD WAR II?

ALTHOUGH the Germans had built and fired huge rocket missiles into England, they spent little time or effort on smaller artillery-type rockets.

However, the Russians, invaded by Germany and desperate for increased firepower, perfected several effective types of rocket batteries. They were almost the only nation fighting in World War II to use rockets on land.

The United States Navy was also quick to test the value of rockets and first used them in the invasion of North Africa in 1942 to give support to landing craft storming the beaches.

Later, in the island battles of the Pacific, when U. S. Marines had gone ashore and the big guns and the air bombing had ceased, it was the rockets that gave support to the land forces.

IS THE ROCKET MISSILE REPLACING ARTILLERY?

DEFENSE against low-flying planes has been stepped up by the Army's HAWK, a quick-firing, solid-propellant missile. It can be fired easily anywhere in the field from a mobile launcher or from small aircraft and helicopters. A sister weapon to the high-altitude Nike HERCULES, it is controlled and directed by special low-altitude radar which can respond instantly to the swiftest enemy plane's attempts to escape.

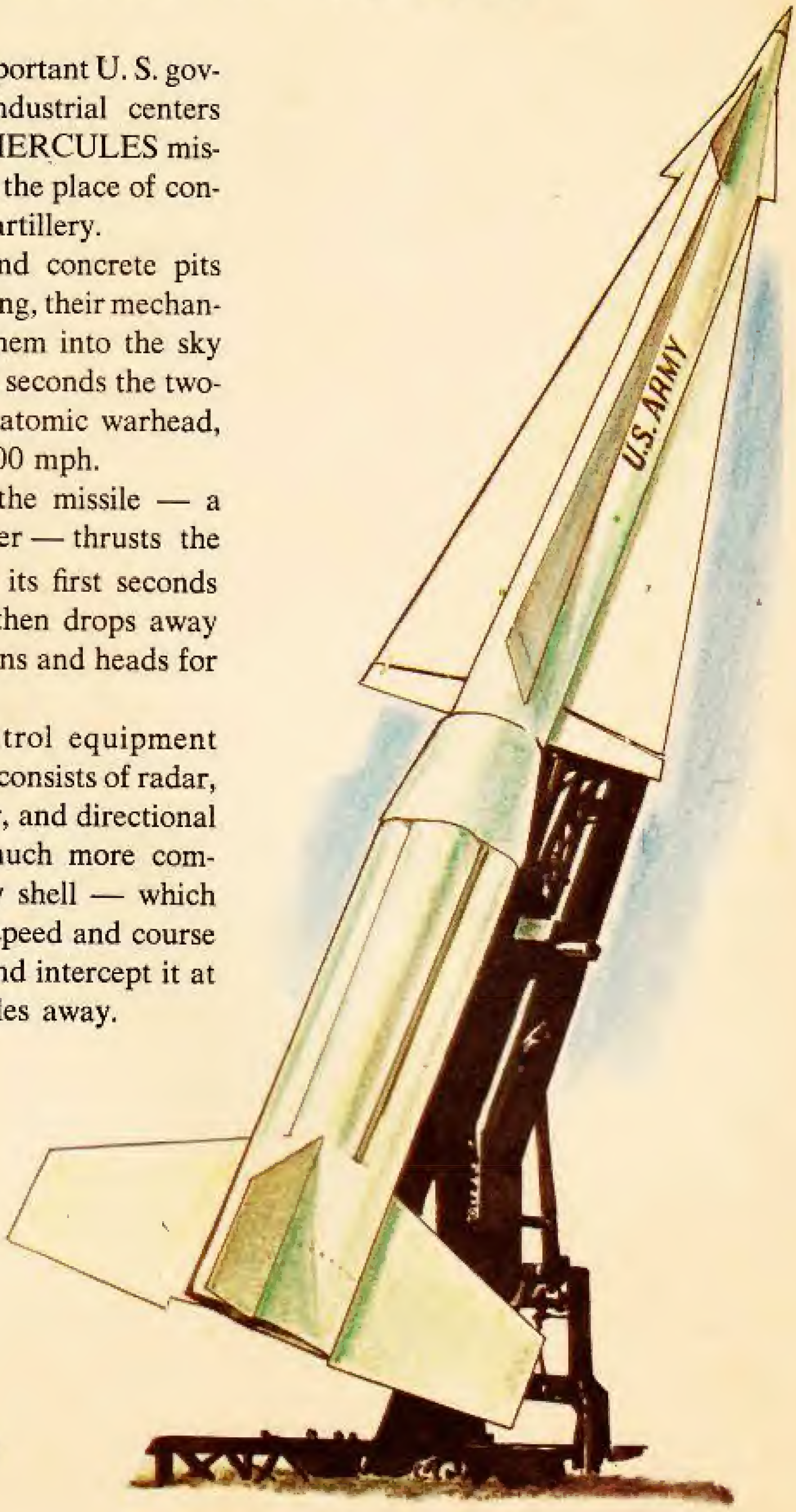
ARE ROCKETS SUPERIOR TO GUNS AS ANTIAIRCRAFT WEAPONS?

RINGING all the important U. S. governmental and industrial centers are batteries of Nike HERCULES missiles which have taken the place of conventional antiaircraft artillery.

Kept in underground concrete pits until the moment of firing, their mechanical launchers point them into the sky and within a matter of seconds the two-stage rocket, with an atomic warhead, can speed aloft at 2,200 mph.

The first stage of the missile — a solid-propellant booster — thrusts the HERCULES through its first seconds of vertical flight and then drops away as the second stage turns and heads for the target.

The elaborate control equipment within its second stage consists of radar, an electronic computer, and directional guidance systems — much more complex than any artillery shell — which take into account the speed and course of an enemy aircraft and intercept it at distances up to 75 miles away.



A Nike HERCULES stands ready for firing.

ARE ROCKETS USED TO DRIVE TARGET DRONES?

WITH the speeds of fighter and bomber aircraft increasing every year and the altitude at which they fly increasing, the fighter pilot's need to perfect his air-to-air aim also increases. To fulfill this need, unmanned target drones have been perfected — small replicas of full-scale planes which can reach the same altitudes and speeds. Some are guided and put through their paces by radio-control from a mother plane.

These drones — unless they are hit during practice — are recoverable by parachute. One type — the FIREBEE, is driven by a small jet engine after it has been boosted to top speed by a rocket.

This rocket-powered drone is used for target practice.

THE XKD4R Navy drone is wholly rocket-powered. The body and wings are made of molded plastic, and it can be launched from a fighter aircraft.

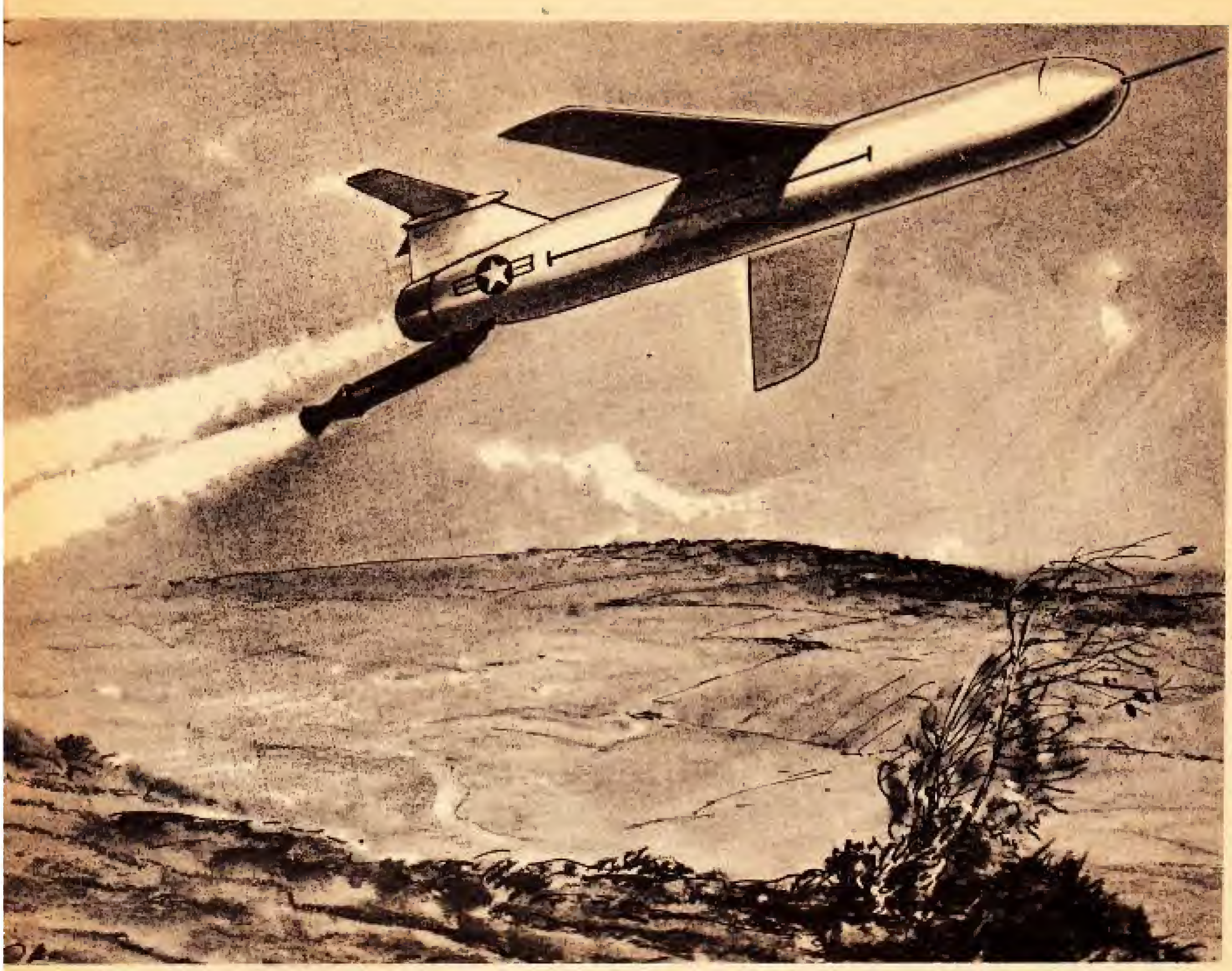
It flies itself, under the mechanical direction of a flight-control package put in place in the fuselage before leaving the ground.

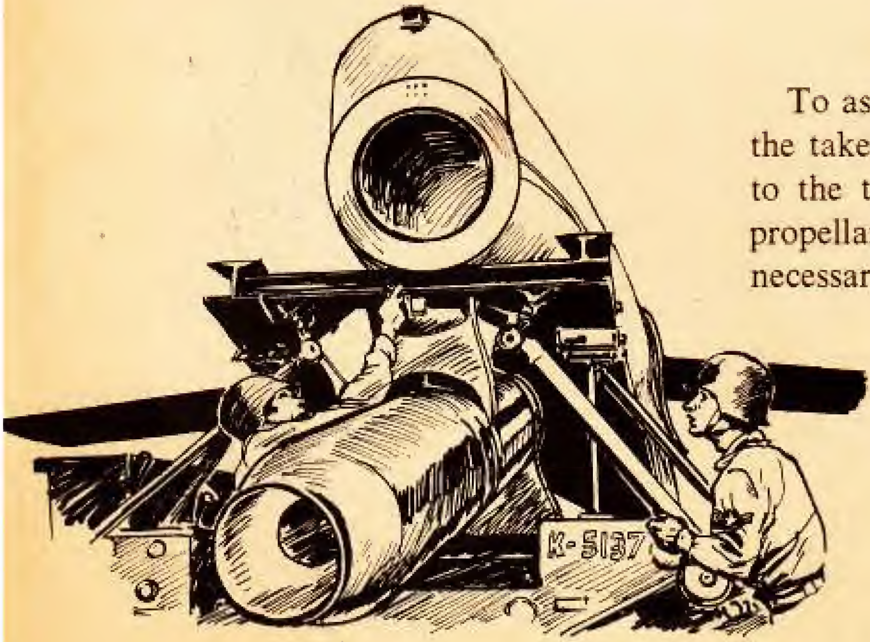
It can duplicate any of the flying characteristics of a full-size plane.

HOW DO ROCKETS "BOOST" JET-PROPELLED MISSILES ON THEIR WAY TO A TARGET?

Air Force combat teams are ready to send the MACE, a pilotless jet-propelled missile with a nuclear warhead, to a target over 600 miles away. These missiles are launched from specially-built powerful vehicles called zero-length-launchers. Near danger points around the world the deadly weapons are hidden along wooded hillsides in Europe, or on tropical coral headlands in the Pacific. Guided after launching, the missile with its fearsome warhead flies to its distant enemy target with unerring accuracy.

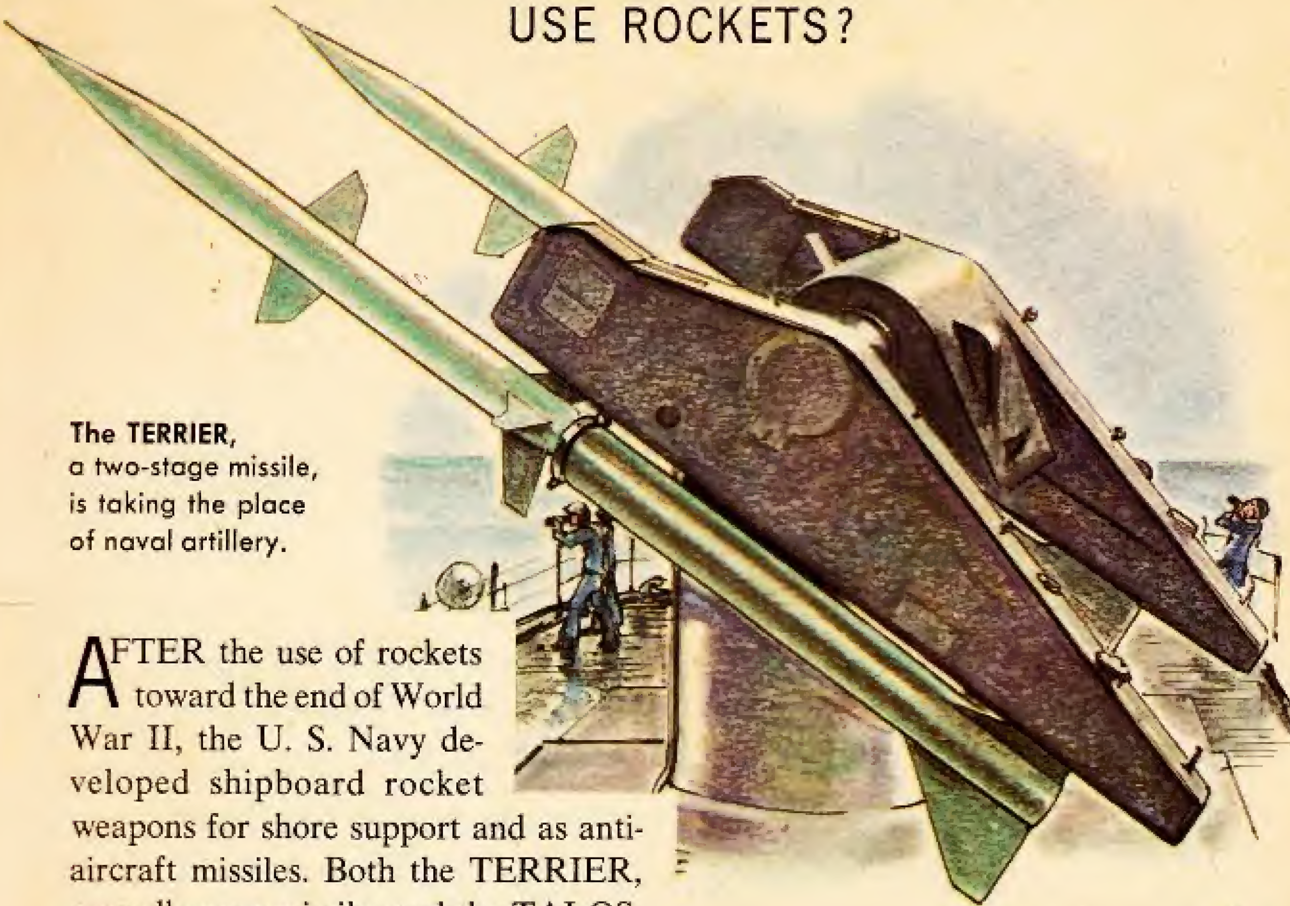
In parts, the MACE and all equipment can be loaded aboard a cargo plane, flown to any part of the world, and be ready for firing within hours.





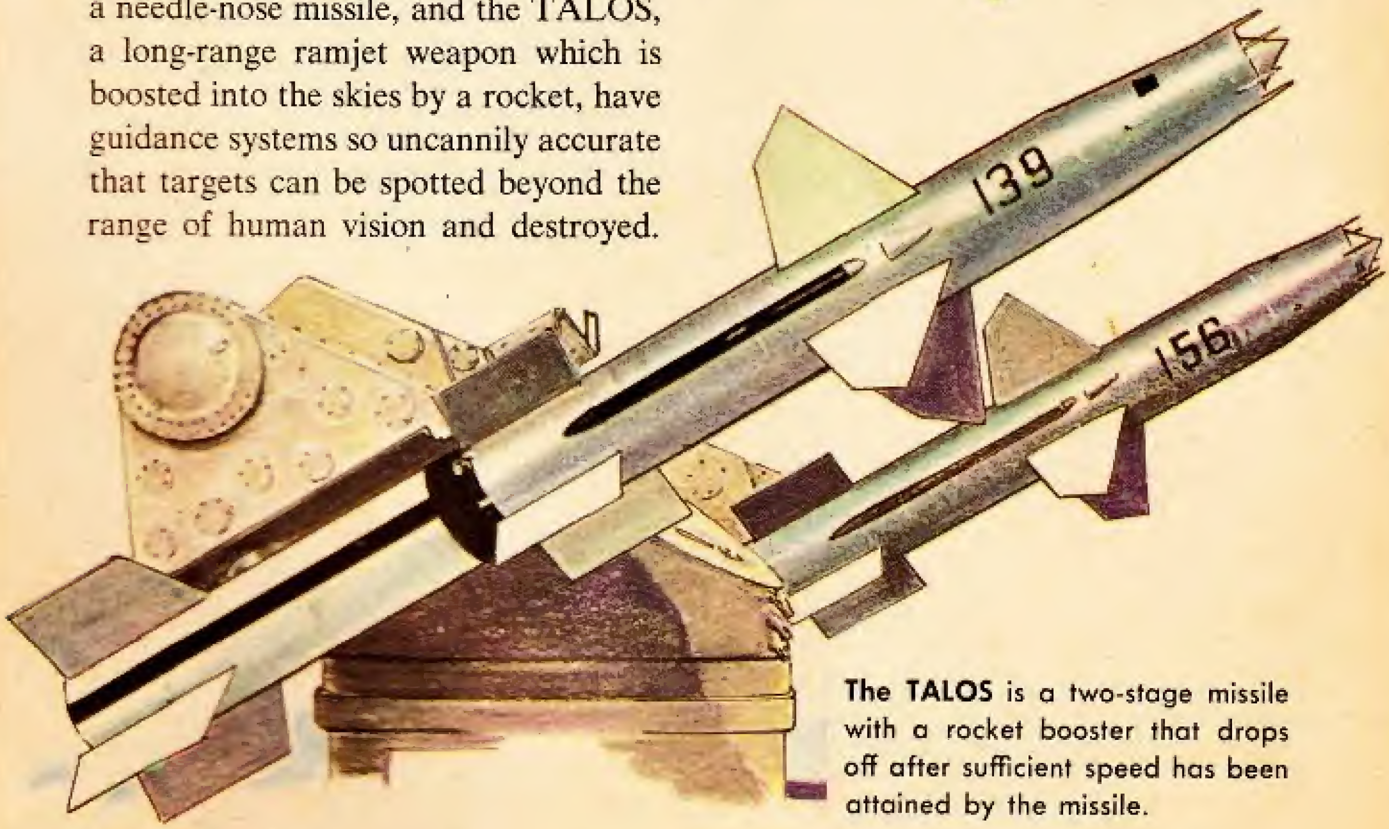
To assist the MACE's jet engine on the take-off, a RATO unit is attached to the tail of the missile. This solid-propellant rocket booster gives it the necessary acceleration toward full flying speed. When this has been achieved and the booster is no longer needed, it falls away, while the MACE goes on alone.

HOW DOES THE UNITED STATES NAVY USE ROCKETS?



The TERRIER, a two-stage missile, is taking the place of naval artillery.

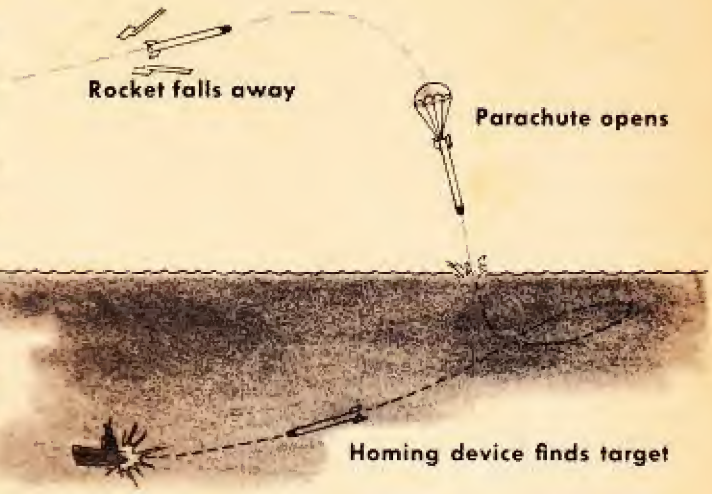
AFTER the use of rockets toward the end of World War II, the U. S. Navy developed shipboard rocket weapons for shore support and as anti-aircraft missiles. Both the TERRIER, a needle-nose missile, and the TALOS, a long-range ramjet weapon which is boosted into the skies by a rocket, have guidance systems so uncannily accurate that targets can be spotted beyond the range of human vision and destroyed.



The TALOS is a two-stage missile with a rocket booster that drops off after sufficient speed has been attained by the missile.

HOW DOES THE UNITED STATES NAVY PLAN TO USE ROCKETS IN UNDERSEA WARFARE?

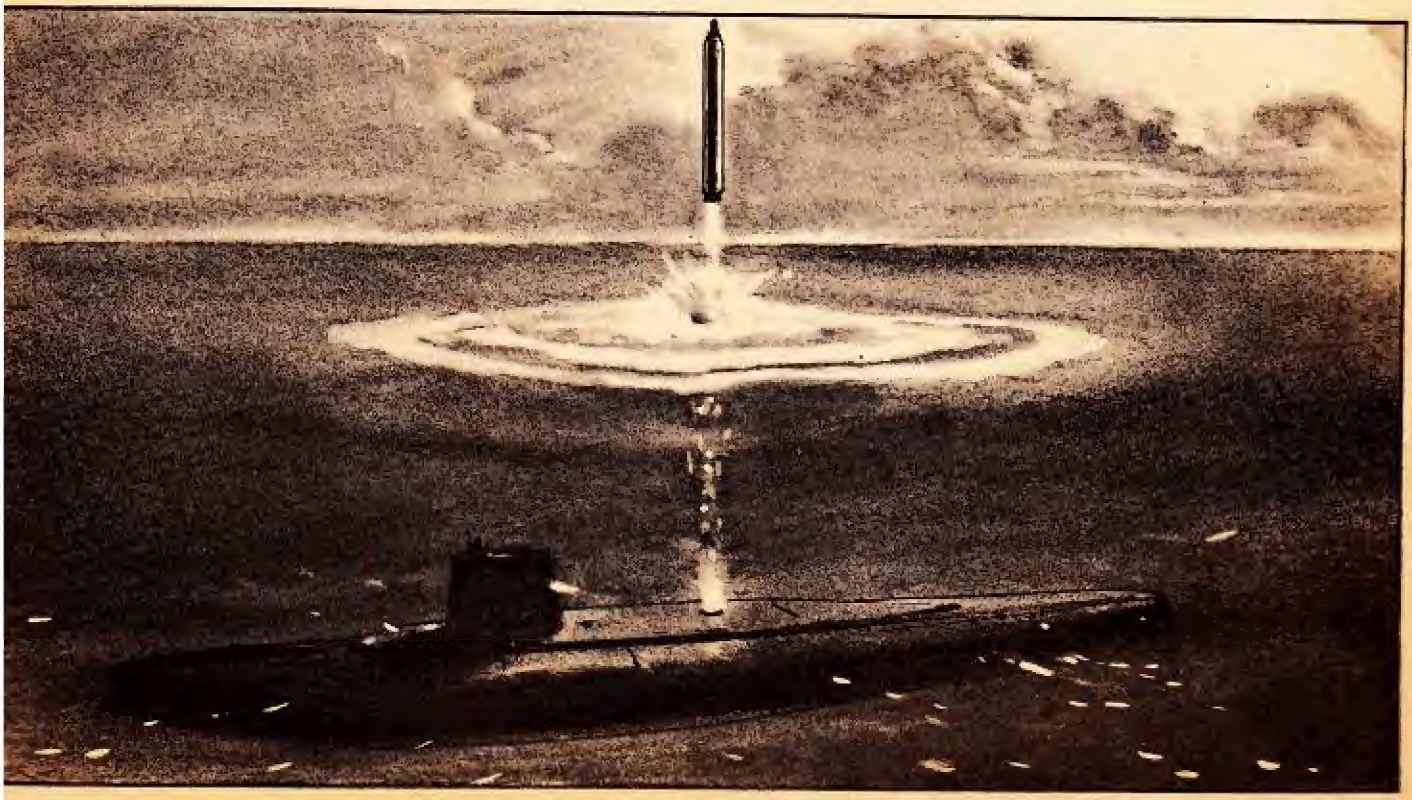
WHEN a lurking enemy submarine is located, surface ships can fire a RAT (rocket-assisted torpedo) toward the suspected area. The rocket hurls the torpedo in the direction of the target, a parachute lowers it into the water close by, and a homing device guides it to the kill.



The U. S. Navy is building a fleet of atomic submarines capable of launching a salvo of POLARIS missiles which can fly supersonically to a target 1,500 miles away.

The submarines can remain submerged far from land for weeks and, when the time comes to strike, can fire their missiles from the depths of the sea or from the surface.

The first successful firing of a ballistic missile from under water took place on July 20, 1960, when a POLARIS missile was fired from the nuclear submarine *George Washington*. At the time of the firing, the *George Washington* was submerged in 50 to 60 feet of water.

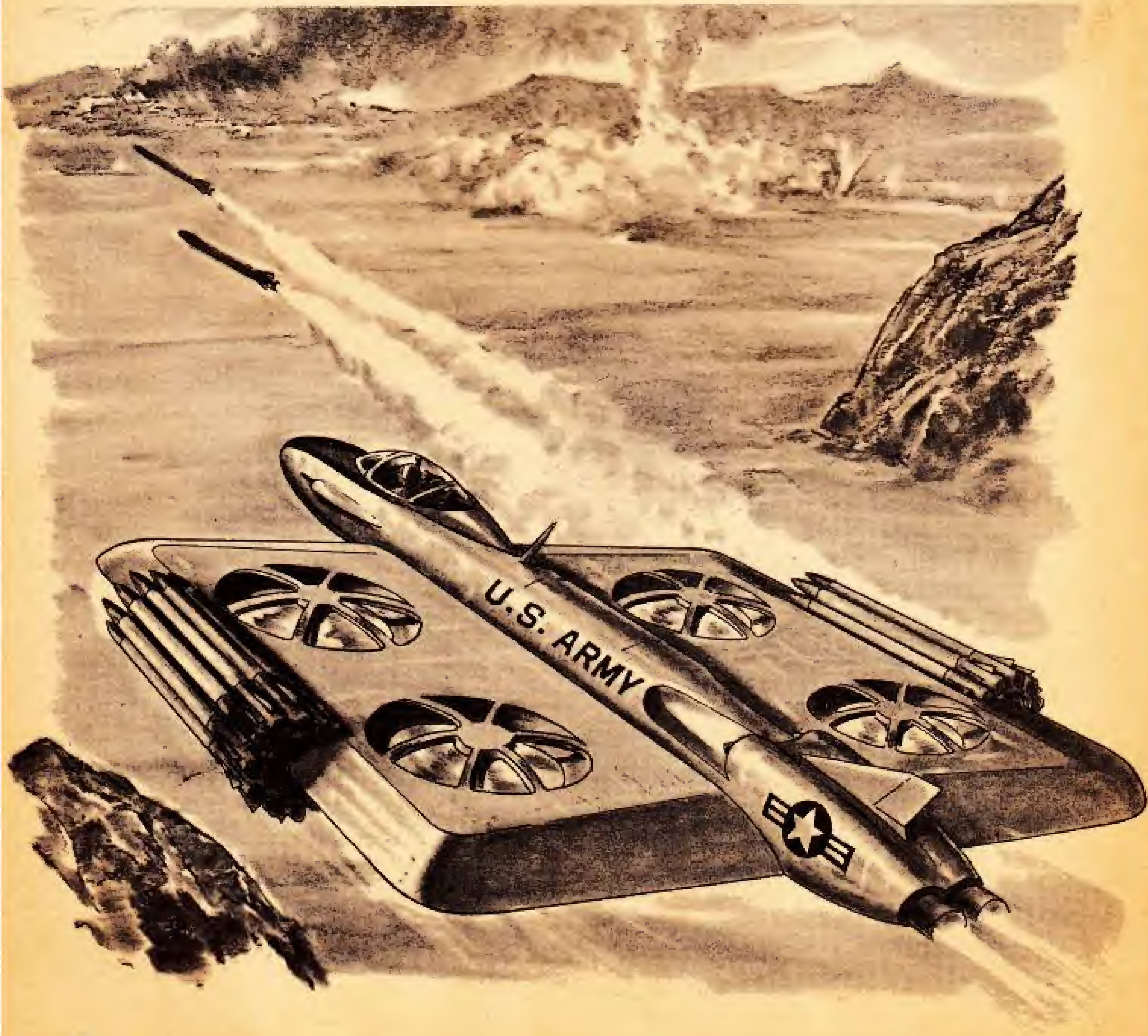


IN WHAT NEW WAYS WILL ROCKETS BE USED?

TO BE sure that atomic battlefields are swiftly occupied after a detonation, new, fast-moving weapons must be devised.

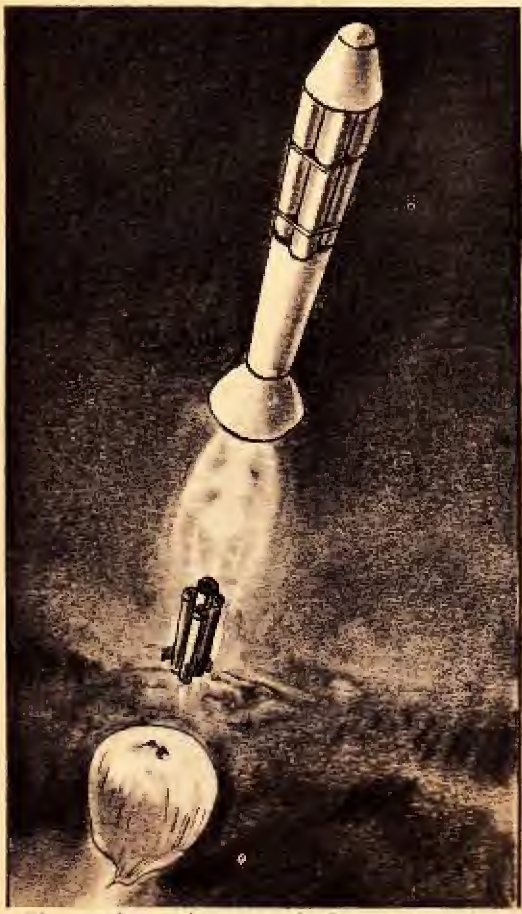
The experimental vertical-rising rocket launcher is designed to fit that need. Powered by two jet engines which also drive four ducted fans for vertical lift, this vehicle is fitted with two revolving banks of rockets that can be fired singly or in salvos to give support to advancing battle groups.

Kept in hiding behind a rampart of mountains, the rocket launchers can proceed to the atomic blast site as soon as radiation lifts, in order to cover the occupation of the battlefield by ground forces without delay.



HOW IS FUEL CONSERVED IN LAUNCHING PROBE ROCKETS?

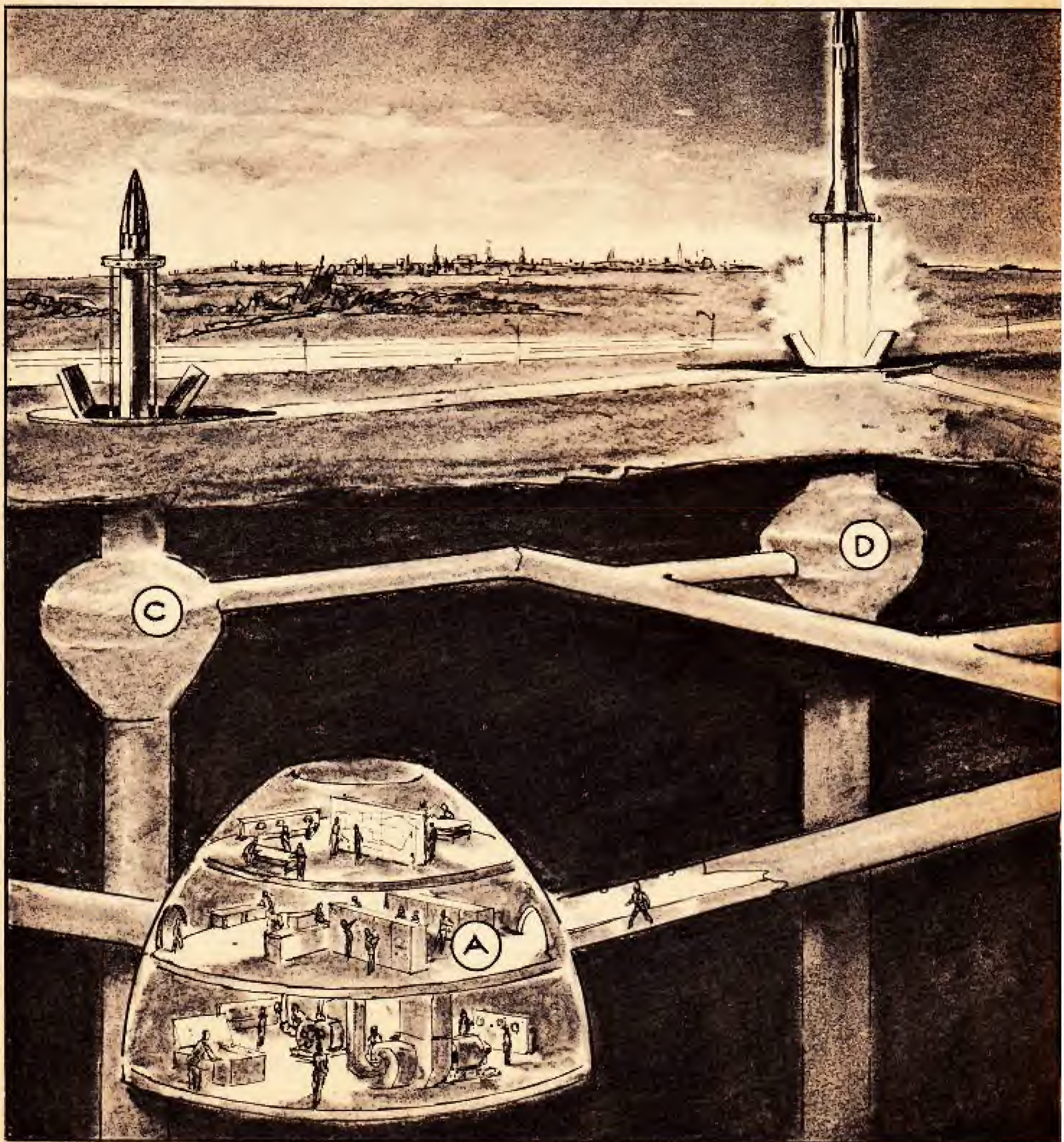
INSTEAD of firing rockets from pads at ground level, the U. S. Air Force, in "Project Farside," sent a multi-stage missile to 100,000 feet altitude, suspended by a polyethylene balloon. At that point the rockets were triggered. Launching the rockets from this altitude instead of from the ground, conserved fuel. Some of them have soared 4,000 miles into space, sending back data on micro-meteorites, temperature and radiation.



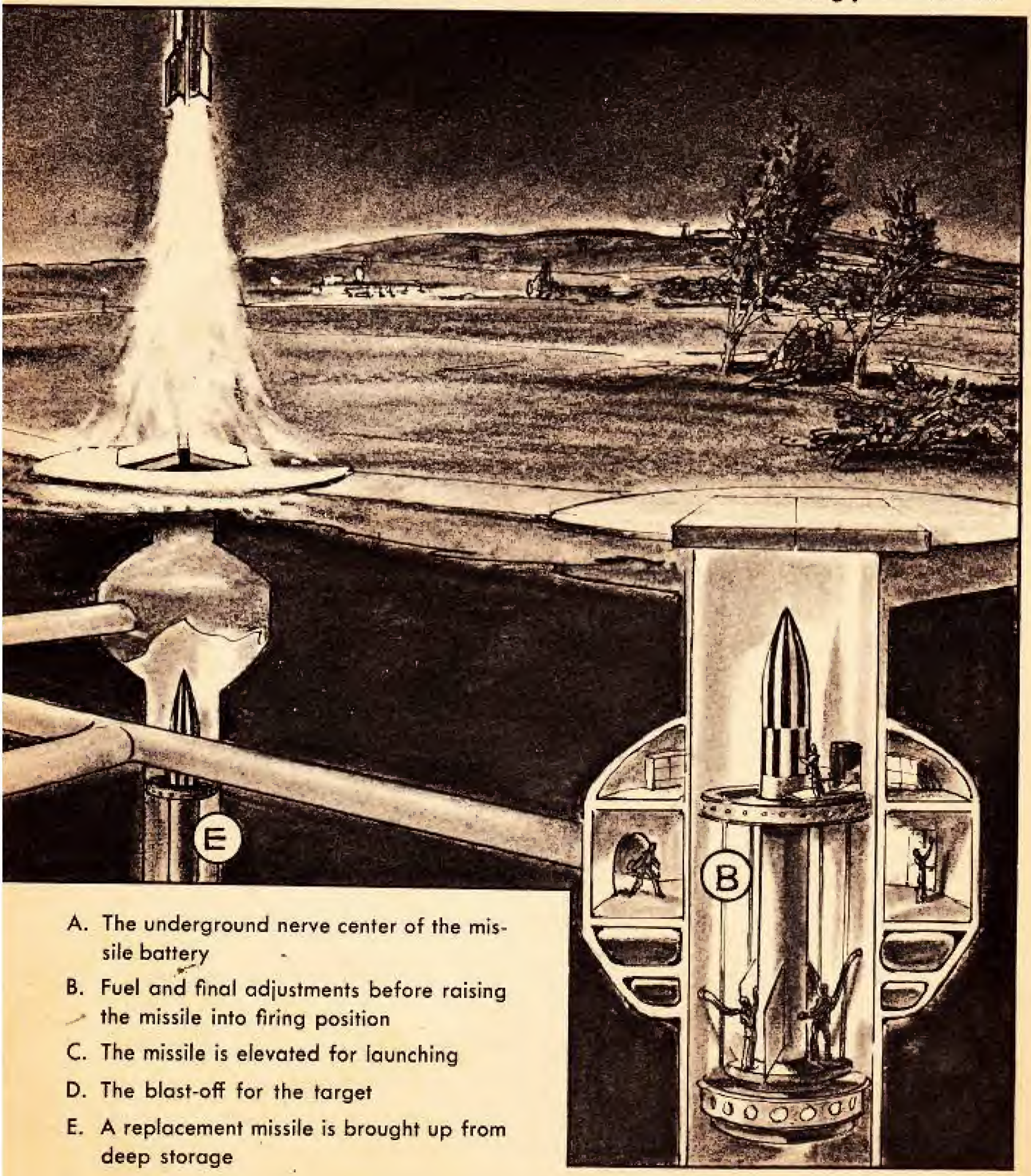
The rocket is launched, destroying the balloon, and soars into space carrying recording instruments.

The rocket frame (on a truck) awaits inflation of the plastic balloon.

HOW WILL PERMANENT MISSILE BASES BE CONSTRUCTED FOR INSTANT USE AGAINST ENEMY ATTACK?



SNUGLY hidden deep below ground-level, long-range missiles stand in readiness for quick firing in case of an enemy attack. Within its underground labyrinth, the missile battery has a Control Center, electronic computers, fueling facilities, supply, and living quarters. When the alarm is sounded, concrete trap doors open and the missiles are brought above ground with aiming and range data already set. The Launch Officer can fire them singly or in salvos.



A. The underground nerve center of the missile battery

B. Fuel and final adjustments before raising the missile into firing position

C. The missile is elevated for launching

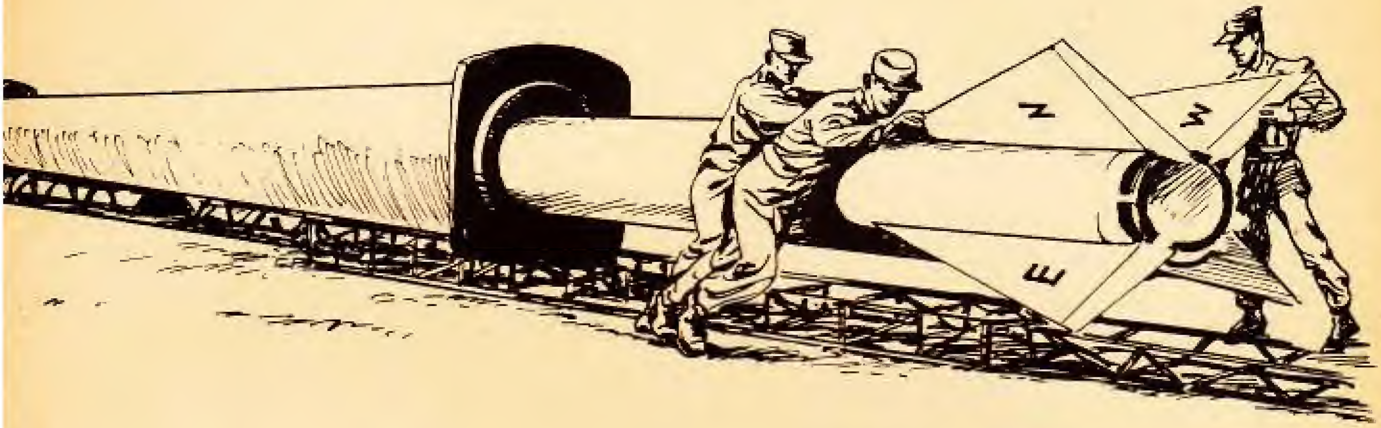
D. The blast-off for the target

E. A replacement missile is brought up from deep storage

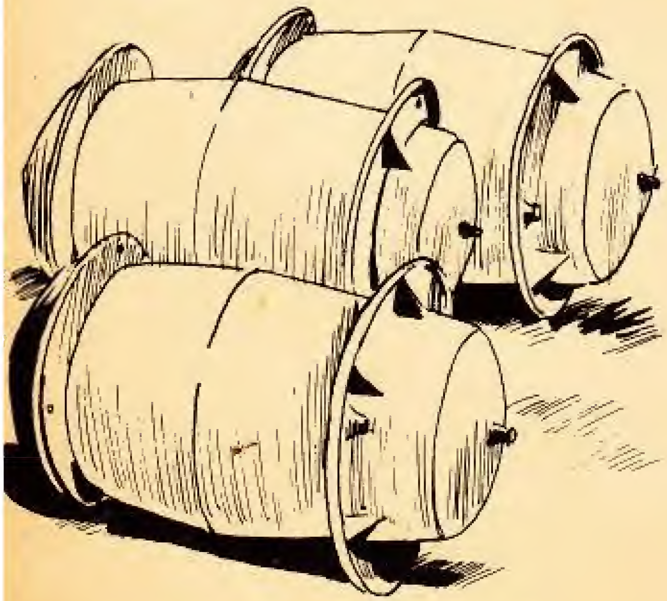
HOW ARE MISSILES LAUNCHED WHERE THERE ARE NO PERMANENT BASES?

THE UNITED STATES ARMY'S CORPORAL missile is delivered to the men in the field encased in a pressurized cylinder 50 feet long, to guard its delicate instrumentation from damage. After it is removed from this protective tube, the nose cone and tail fins are secured in place and a giant transporter vehicle takes the missile to the fueling station where chemicals are pumped into it from steel fuel tanks.

Without the launching facilities to be found at a permanent missile base, all sorts of strange vehicles are needed.

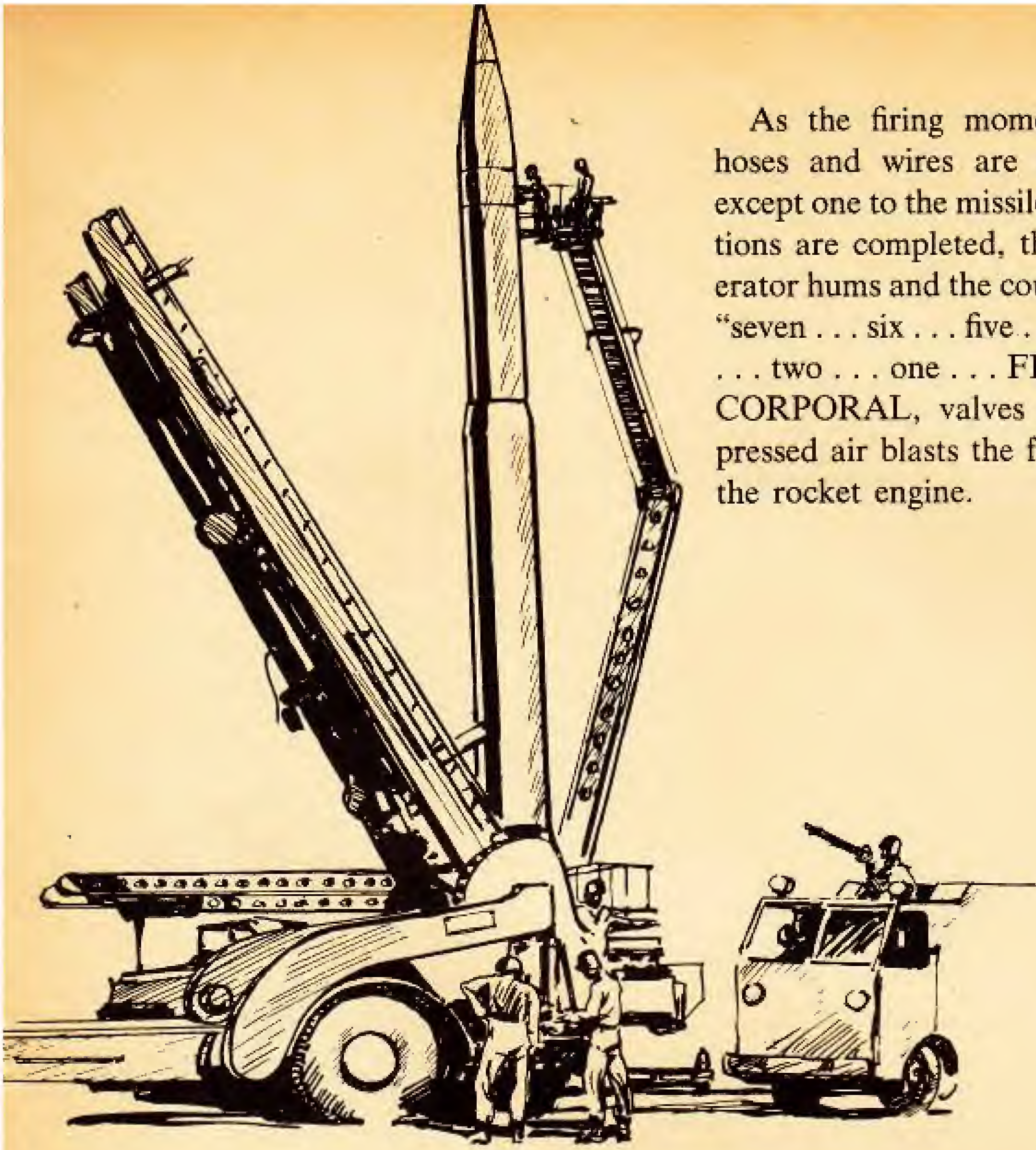


Missile being removed from shipping case



These tanks contain aniline, a fuel used in the launching of missiles.

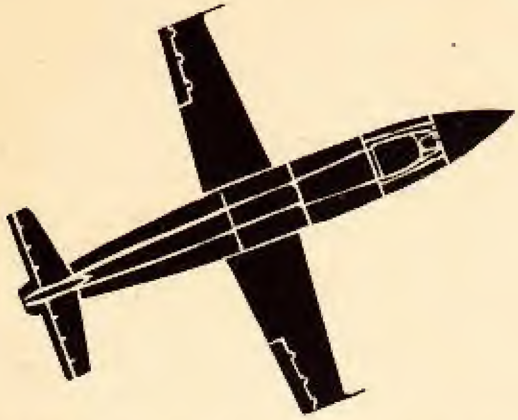
Vans which house radar tracking instruments and electronic computers must be placed in position. The transporter slowly points the missile upward and sets it upon a portable steel platform on the ground. To enable men to reach any part of the vertical missile, a portable crane is used for the last-minute adjustments. A fire truck stands by in case of an accident. Electric cables and hoses may be seen everywhere, supplying fuel, power and data for the launching.



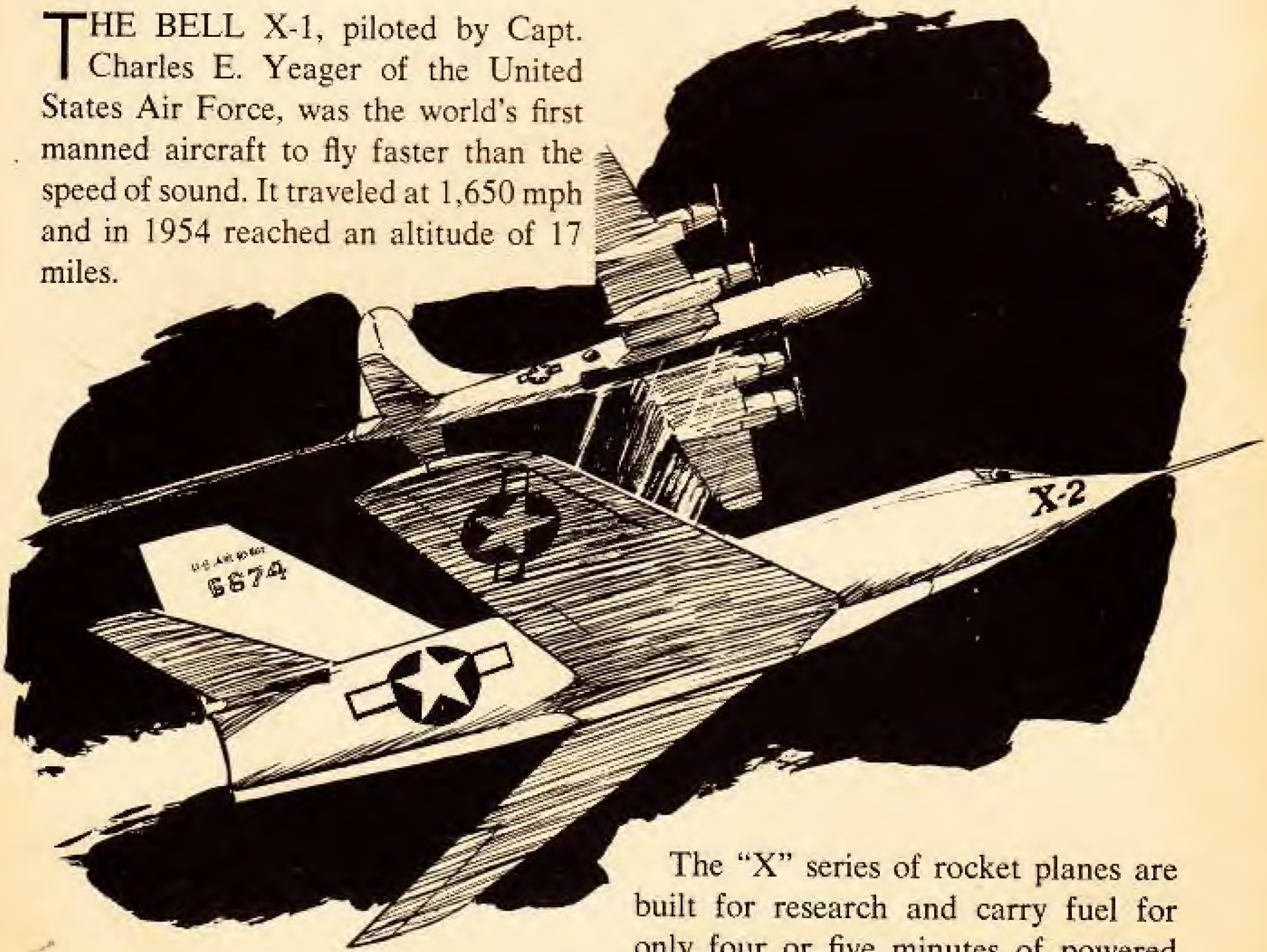
As the firing moment approaches, hoses and wires are reeled in — all except one to the missile. Final preparations are completed, the portable generator hums and the countdown begins: "seven . . . six . . . five . . . four . . . three . . . two . . . one . . . FIRE!" Inside the CORPORAL, valves open and compressed air blasts the fuel mixture into the rocket engine.

A roar is heard, dust scatters in an explosive cloud around the base of the missile and — ever so slowly at first — the CORPORAL begins its fire-trailing ascent into the sky. Two miles up, it tilts and screams off toward a target 60 to 70 miles away.

WHAT RECORDS WERE MADE WITH AMERICA'S FIRST ROCKET PLANES?



THE BELL X-1, piloted by Capt. Charles E. Yeager of the United States Air Force, was the world's first manned aircraft to fly faster than the speed of sound. It traveled at 1,650 mph and in 1954 reached an altitude of 17 miles.



Rocket-driven planes having broken the sound barrier, the X-2 was designed to probe the thermal barrier — that point at which it was feared the terrific speeds might melt the structure of the craft. Built of titanium (lighter than steel), it flew over 2,100 mph and in 1956 it climbed to 25 miles above the surface of the earth. Its rocket engines burned an alcohol-water mixture and used liquid oxygen as an oxidizer.

The "X" series of rocket planes are built for research and carry fuel for only four or five minutes of powered flight. Carried aloft under the wing of a mother plane, they are released above 35,000 feet, where the rocket engines are ignited.

WHAT IS THE ROCKET PLANE X-15 EXPECTED TO ACCOMPLISH?

THE X-15, an experimental rocket plane, was developed for speeds of up to 4,000 mph and a flight ceiling of 100 miles. It has a wing span of 22 feet. The X-15 is launched in the air from

a giant B-52 at an altitude of 40,000 to 50,000 feet. The engines are designed to fire for only 90 seconds. Then they stop and the rockets glide back to earth.

On October 11, 1961, Major Robert M. White of the United States Air Force took off from Edwards Air Force Base in California in the X-15. After being released from the B-52, the rocket plane set a winged-flight record by ascending to 217,000 feet, more than 41 miles above the earth. In the controlled flight, Major White flew above 99.9 per cent of the earth's atmosphere.

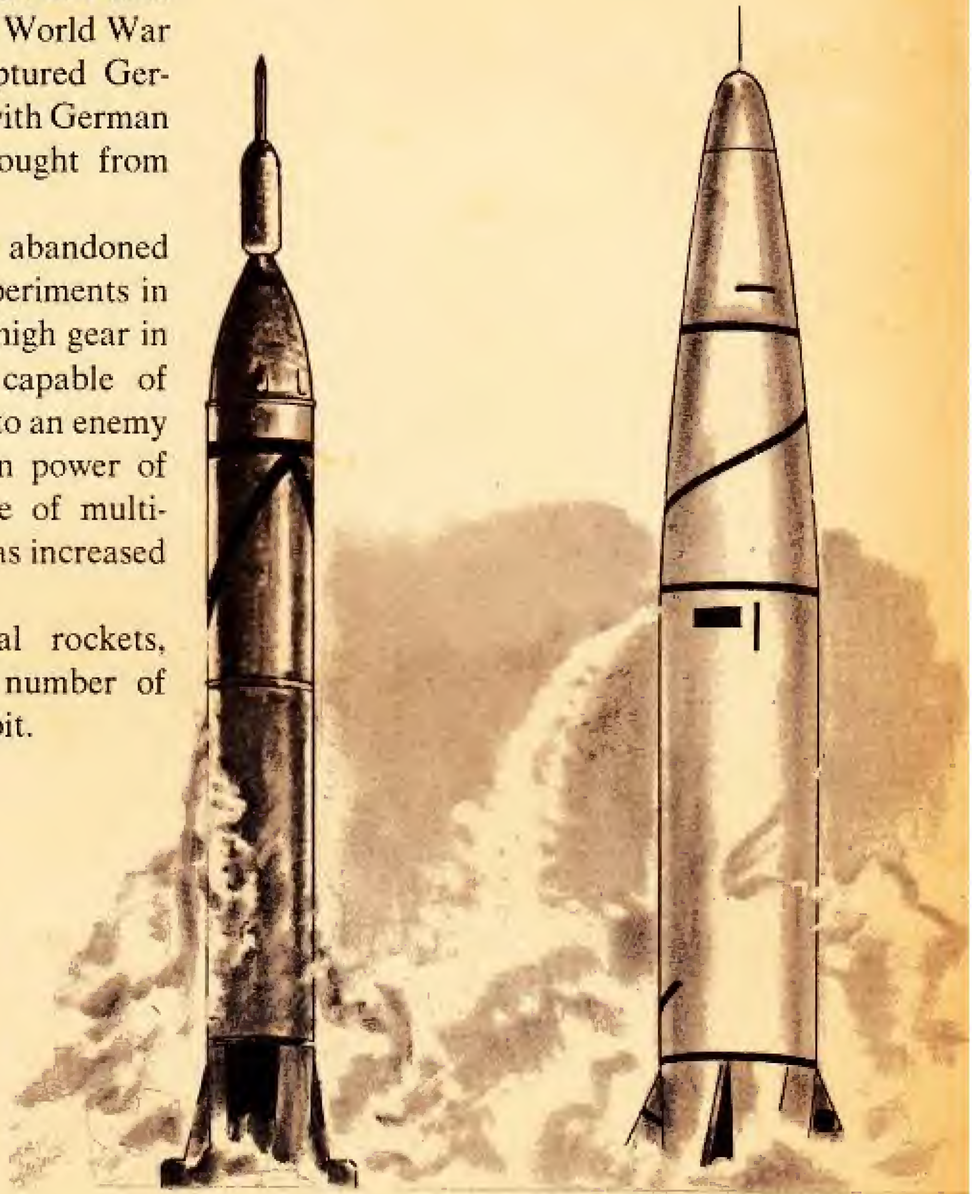
On October 17, 1961, Joe Walker, a pilot for the U. S. National Aeronautics Administration, set a new speed record in the X-15. The rocket plane achieved a speed of 3,920 mph, which is almost six times the speed of sound.

WHICH ARE THE UNITED STATES LONG-RANGE MISSILES?

MISSILE experiments in the United States Army, Navy and Air Force began soon after the end of World War II, when a quantity of captured German V-2 missiles, together with German rocket specialists, were brought from Europe.

Rocket building, almost abandoned since Robert Goddard's experiments in the early 1900's, went into high gear in order to perfect missiles capable of carrying a nuclear warhead to an enemy target. With the increase in power of rocket engines and the use of multi-stage missiles, their range was increased to over 5,000 miles.

Combinations of several rockets, mounted in stages, put a number of American satellites into orbit.



The *Saturn*, described as "the world's largest rocket," is 162 feet tall and weighs 925,000 pounds. Its booster is made up of eight rocket engines clustered together, and it produces a thrust of 1,500,000 pounds at take-off. The first launching of the *Saturn* took place at Cape Canaveral, Florida on October 27, 1961. Ballistic missiles are passing through experimental phases, which will probably change their size, weight and configuration many times in the future.

	JUPITER	THOR
Service Branch	U.S. Army	U.S. Air Force
Height (feet)	58	62
Weight (pounds)	105,000	110,000
Range (miles)	1,500	1,500
Contractor	Chrysler	Douglas

REDSTONE

U.S. Army
69
?
200+
Chrysler

VANGUARD

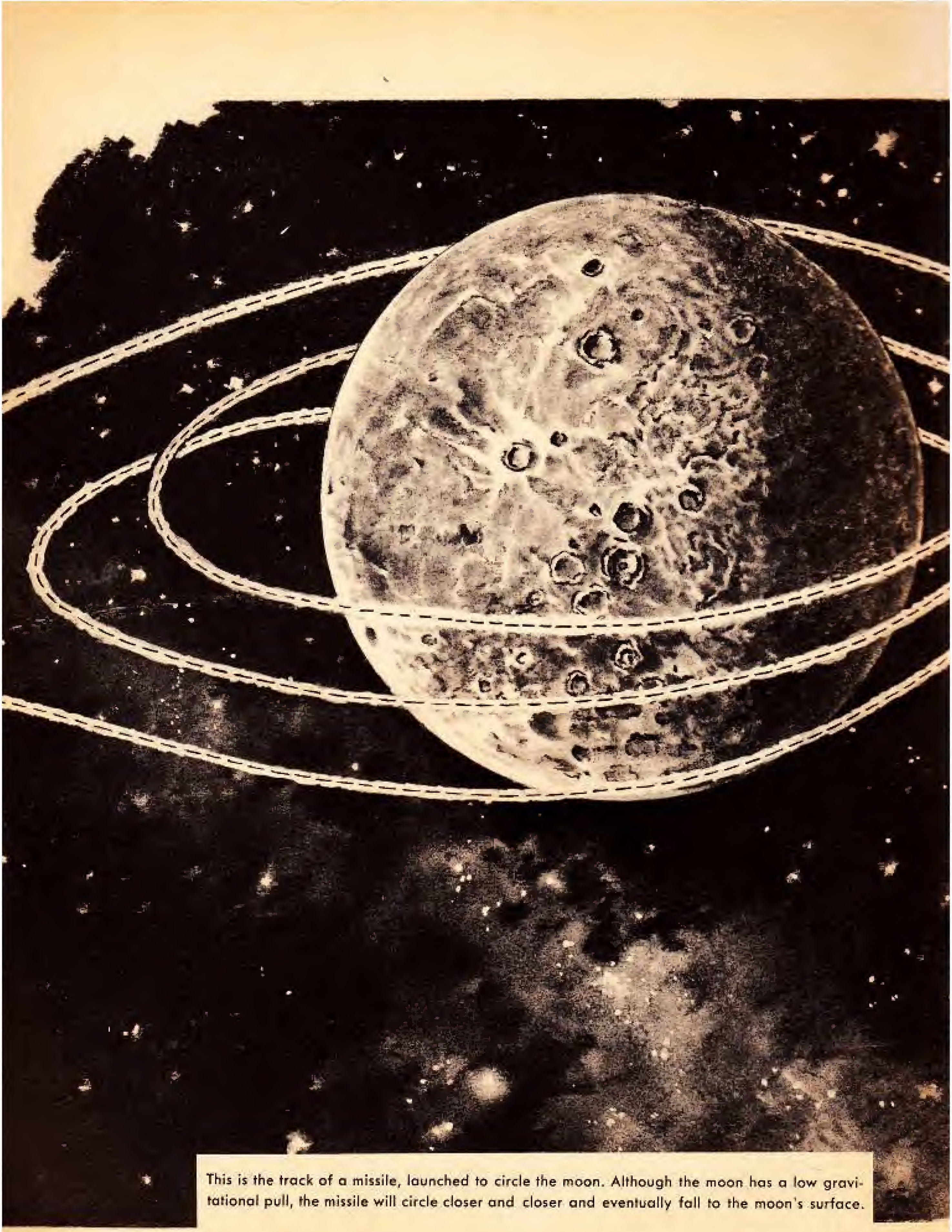
U.S. Navy
72
22,000
300 Mi. Alt.
Martin

ATLAS

U.S. Air Force
75
243,000
9,000
Convair

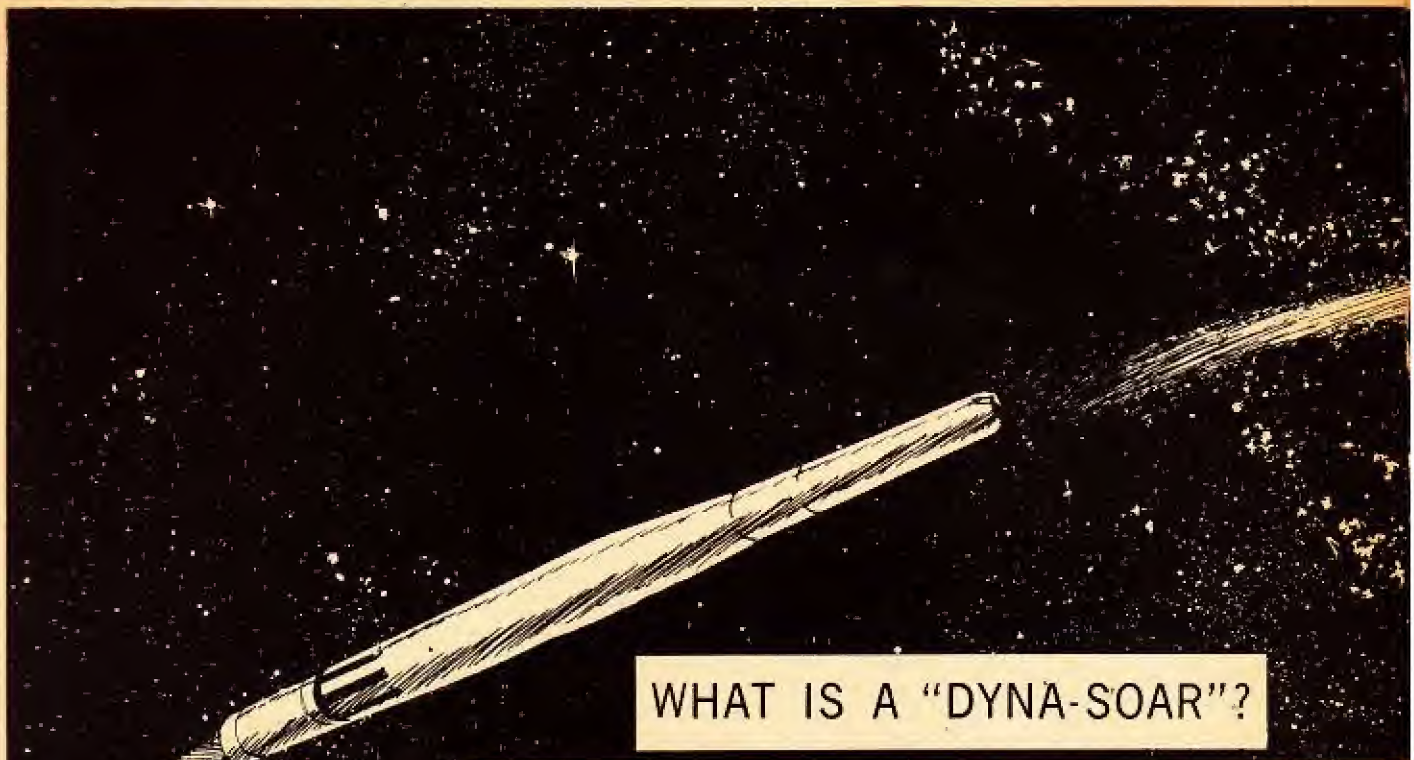
HOW FAST MUST A MISSILE TRAVEL TO ESCAPE FROM THE EARTH'S GRAVITATIONAL PULL?

TO GO to the moon — our only natural satellite—a rocket missile must attain a speed of 25,000 mph to escape from the earth's pull. This must be done with multi-stage rockets, each individual stage sending the missile farther into space and at increasing speed. When the last stage is fired, the missile must be traveling at seven miles per second. At this point it will continue to coast, without power, and scientists believe that as it comes within 30,000 miles of the moon, the missile will begin to orbit around that body.

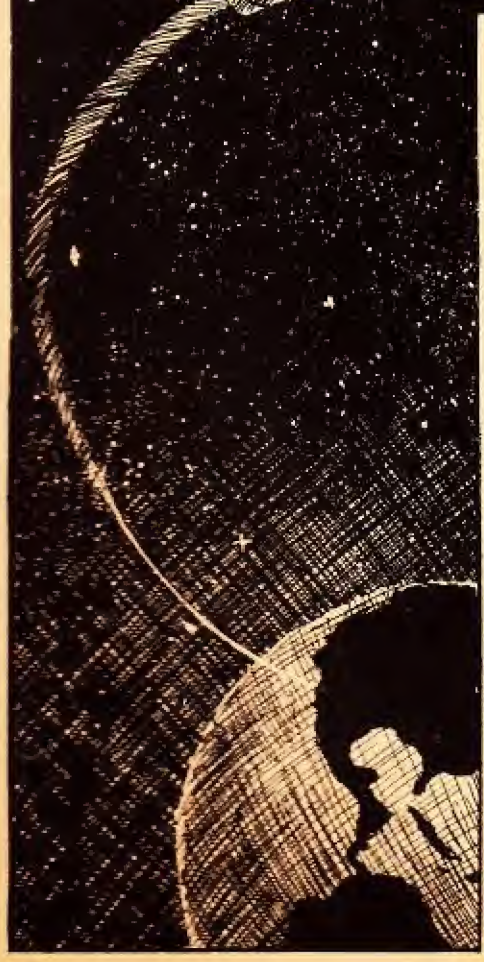


This is the track of a missile, launched to circle the moon. Although the moon has a low gravitational pull, the missile will circle closer and closer and eventually fall to the moon's surface.

The orbiting section of the DYNA-SOAR has just separated from the booster. The booster frequently tumbles in space until its speed drops and it falls into the denser atmosphere of the earth where it burns up, due to friction.

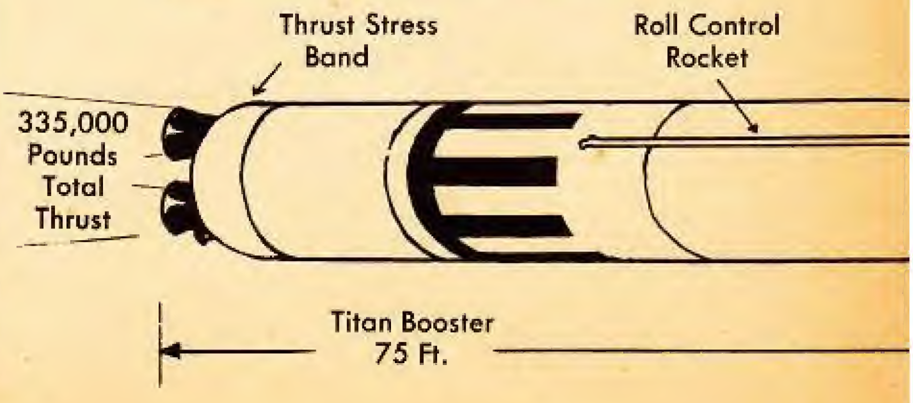


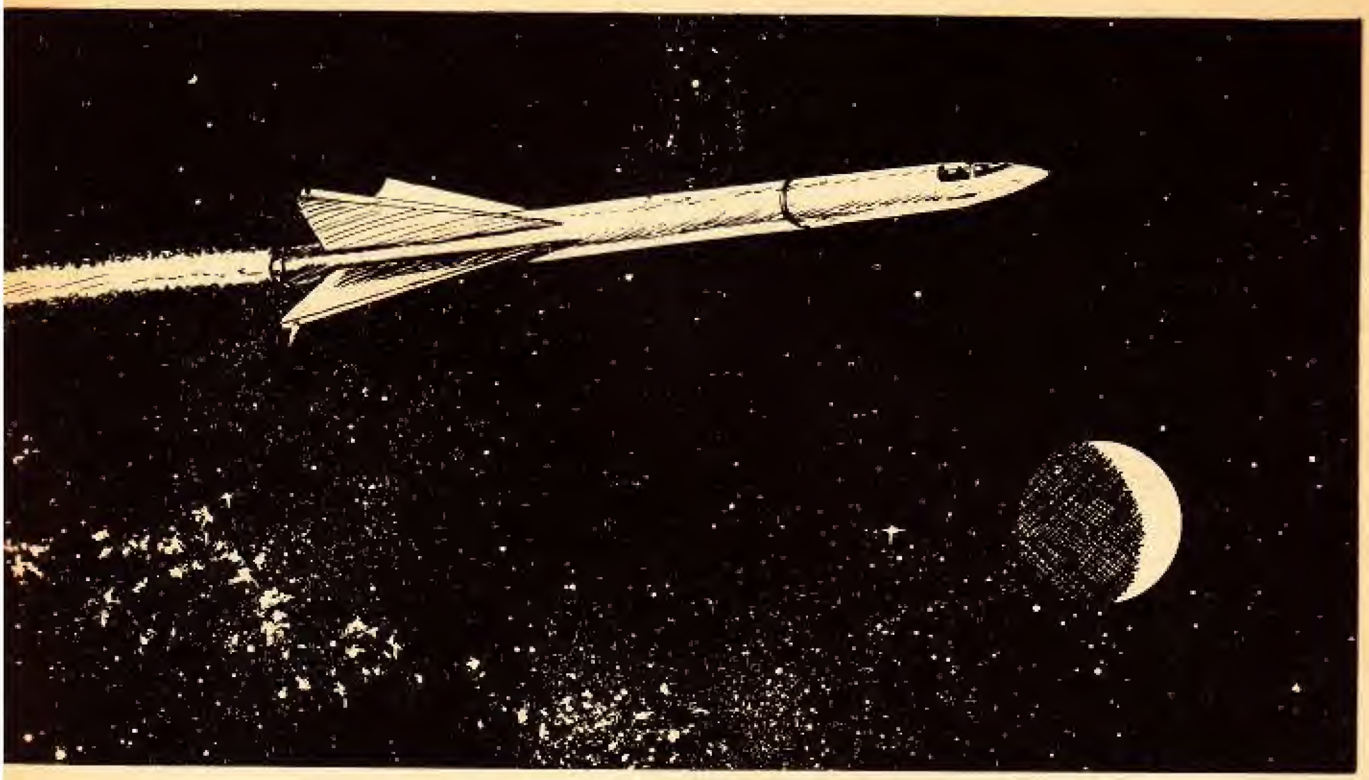
WHAT IS A "DYNA-SOAR"?



THE X-15, about which you read on page 25 of this book, is the forerunner of the first real space rocket, the Boeing DYNA-SOAR.

The name DYNA-SOAR comes from the words "dynamic soaring," which is a way of describing a man-carrying, winged space glider boosted out to the fringes of the earth's atmosphere by a modified TITAN ICBM missile. The United States Air Force program on DYNA-SOAR will be the

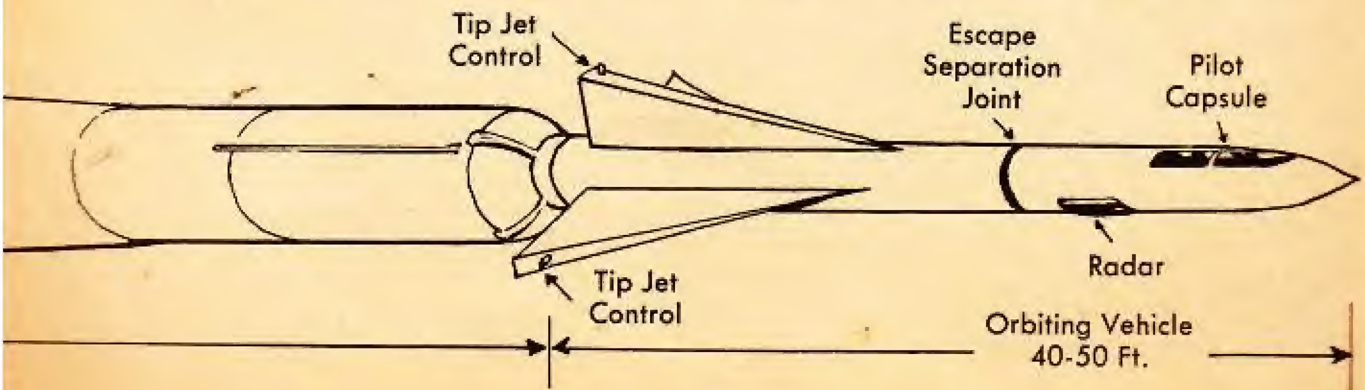




first steppingstone toward an orbital reconnaisance patrol bomber. By using the same principles as the X-15, the DYNA-SOAR, after being launched from a mother bomber plane, is designed to develop a speed of about 17,000 mph. This will enable it to skip in and out of the atmosphere and finally glide home, using its wings, ailerons and rudder like an ordinary airplane.

To withstand the terrific strains, the DYNA-SOAR will be constructed throughout of high-strength alloy steel, not only to resist the corrosive action of rocket fuels and oxidizers, and the impact of micrometeorites during high flight, but also the searing heat caused by its re-entry into the earth's dense atmosphere, as well as the intense cold of outer space.

By the time DYNA-SOAR is ready for the first astronauts, it is hoped that there will be new and more powerful rocket engines — even a nuclear one.



WHY MUST ROCKETS BE USED FOR TRAVEL IN OUTER SPACE?

WHEN man flies through the ionosphere — extending from 50 to 500 miles above the earth — and continues into the exosphere, he will be arriving in outer space where no atmosphere exists. Long before this point is reached, piston and jet engines would have stopped running because, to continue to operate, they must draw in air (oxygen) to mix with the fuel they use.

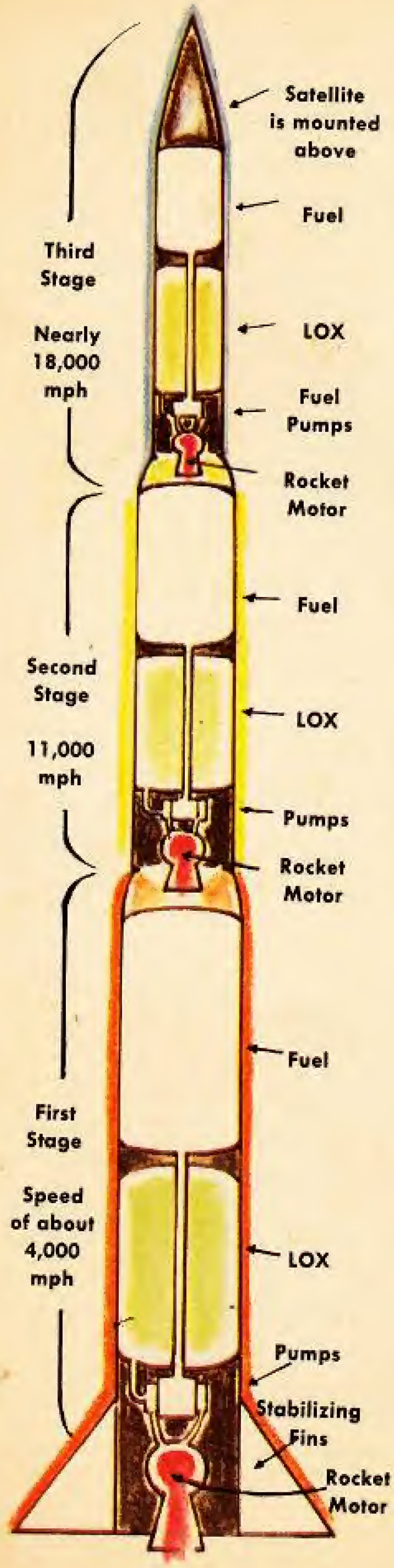
It was the American rocket scientist, Robbert Goddard who first proved, both mathematically and by actual test, that a rocket will work in a vacuum. Its fuel, when mixed with an oxidizer (liquid oxygen) in the rocket firing chamber will explode and burn, creating *thrust*. Therefore, the rocket engine is unlike any other in that it carries its own "air" with it.

Another of its advantages for manned space travel is that its speed of acceleration can be so controlled by the flow of fuel, that the initial "blast-off" from the ground can be kept at speeds man can stand.

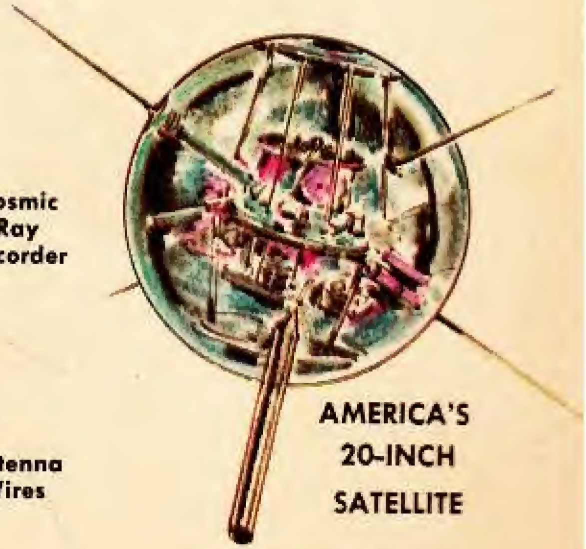
This four-barreled rocket engine, weighing only 210 pounds, produced 6,000 pounds of *thrust*. It pushed the X-1 through the sonic barrier to a height of 90,000 feet.

HOW IS A MULTI-STAGE MISSILE CONSTRUCTED?

IT WAS America's own Dr. Goddard who first discovered that by mounting one rocket atop another — automatically firing the next stage above when the first had burned out — speeds and distances could be achieved that were impossible with a single-stage rocket. In some instances, the instrument-carrying satellite has its own rocket engine which goes into orbit, too.



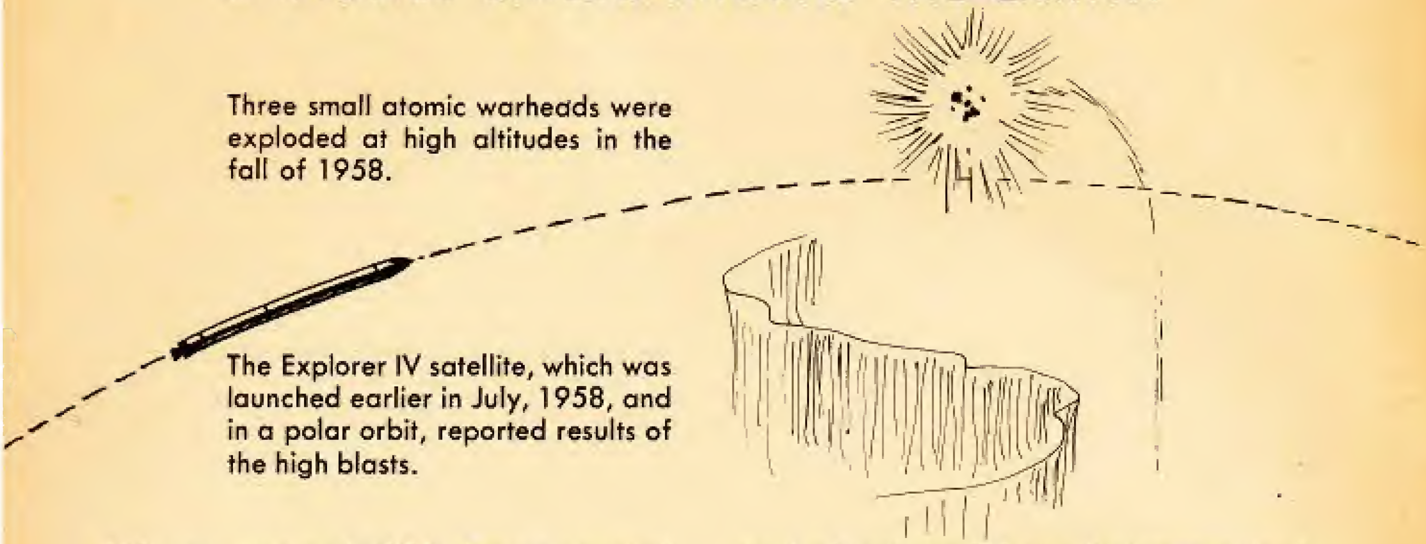
JUPITER-C SATELLITE



AMERICA'S 20-INCH SATELLITE

Released from a protective nose cone, this instrumented satellite goes into orbit.

HOW DID PROJECT ARGUS CREATE A MISSILE SHIELD AROUND THE EARTH?

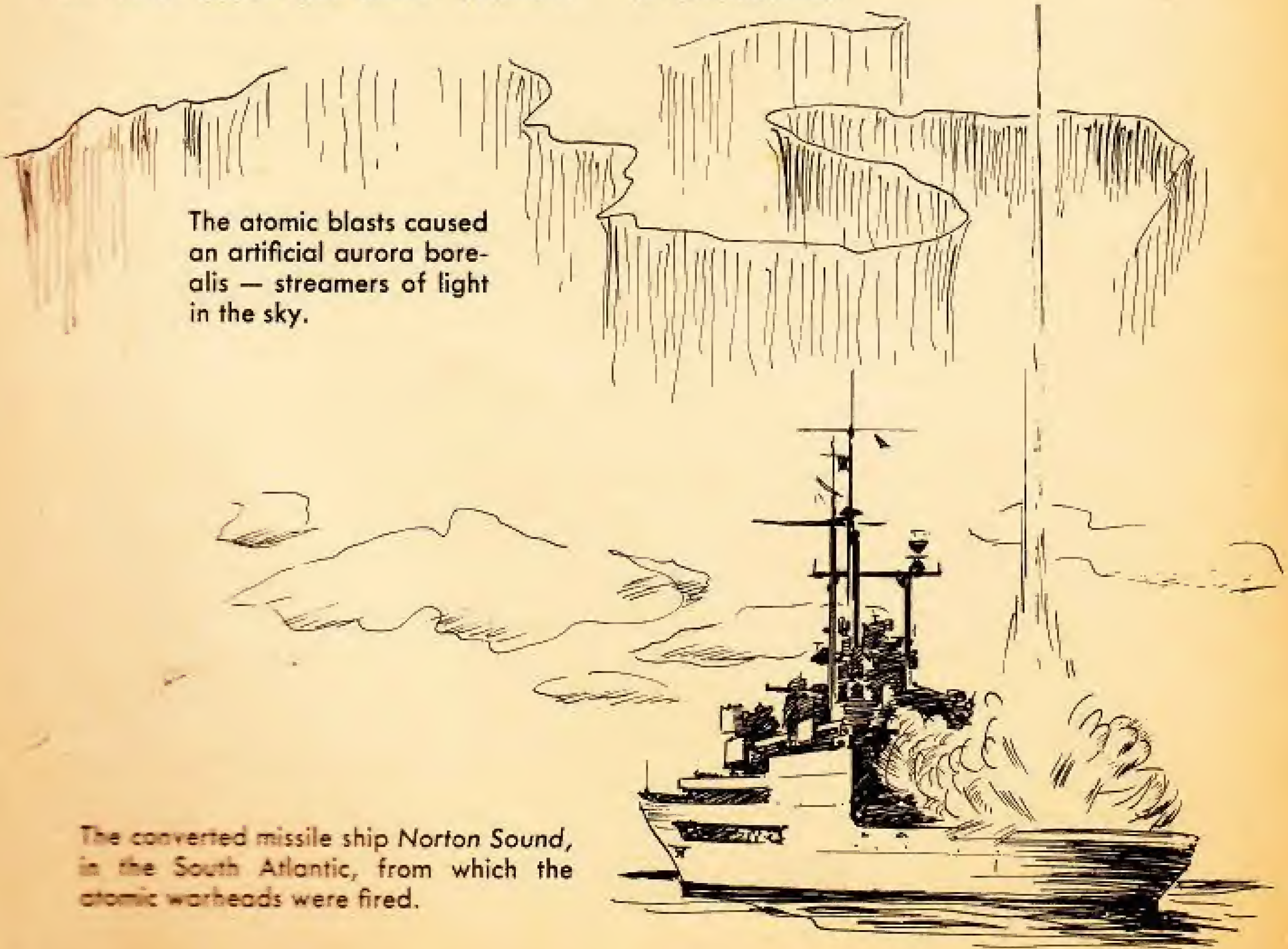


Three small atomic warheads were exploded at high altitudes in the fall of 1958.

The Explorer IV satellite, which was launched earlier in July, 1958, and in a polar orbit, reported results of the high blasts.

IN the autumn of 1958, during a period of ten days, three atomic warheads were secretly fired at an altitude of 300 miles above the South Atlantic.

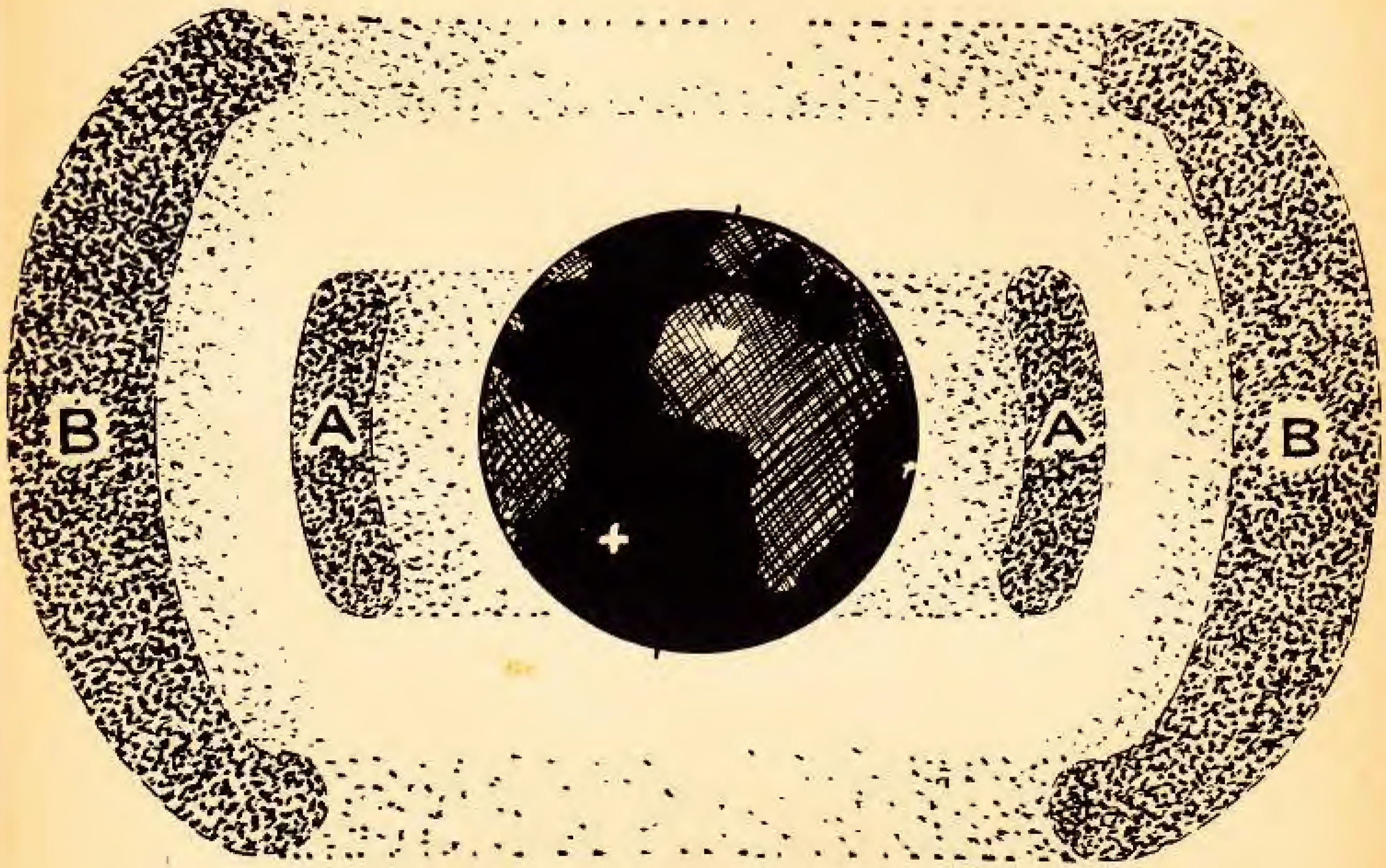
As the Explorer IV satellite approached on its orbiting circle around the earth, it sent back factual reports on radiation at that altitude.



The atomic blasts caused an artificial aurora borealis — streamers of light in the sky.

The converted missile ship *Norton Sound*, in the South Atlantic, from which the atomic warheads were fired.

From instrumented satellites that have been sent into orbit around the earth, it has been determined that there are two belts of intense radiation that surround our planet — except for areas over the two poles. One (A), exists about 3,500 miles beyond our atmosphere and another belt of radiation (B), exists between 8,000 and 12,000 miles beyond our atmosphere.



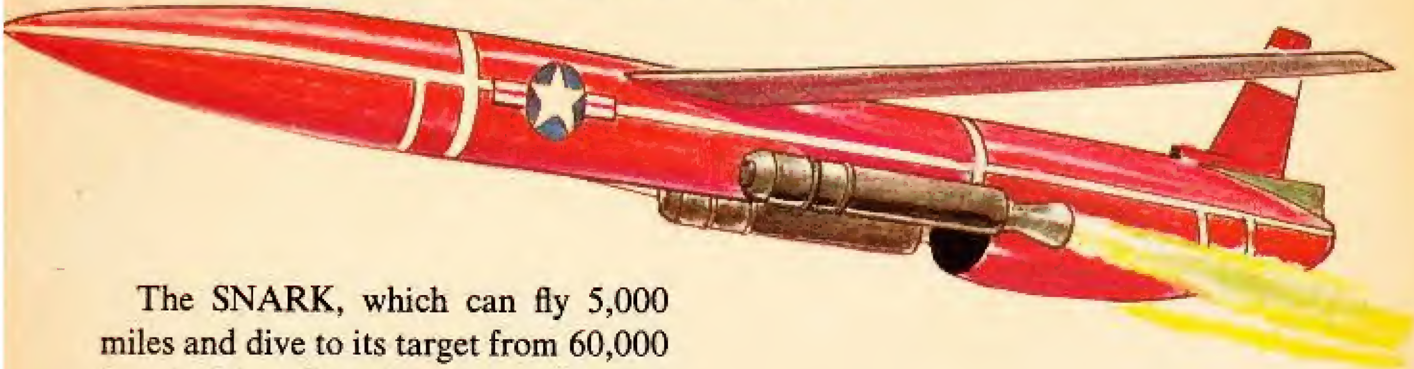
The instrumented satellite that was sent up from the South Atlantic (shown by the white cross) verified the fact that there are two distinct belts of radiation in outer space partially encompassing the earth.

When Task Force 88 was sent to the South Atlantic to carry out *Project Argus,* it was uncertain what would result. When the 300-mile-high nuclear explosions occurred, they released negatively charged electrons which were caught up by the earth's invisible magnetic field and swept eastward. Within an hour they had enveloped our planet in a thin veil of radiation. Radar and radio transmissions were effectively disrupted.

Many scientists agree that by releasing neutrons in the same way, enemy supersonic missiles might be exploded harmlessly, high in the sky.

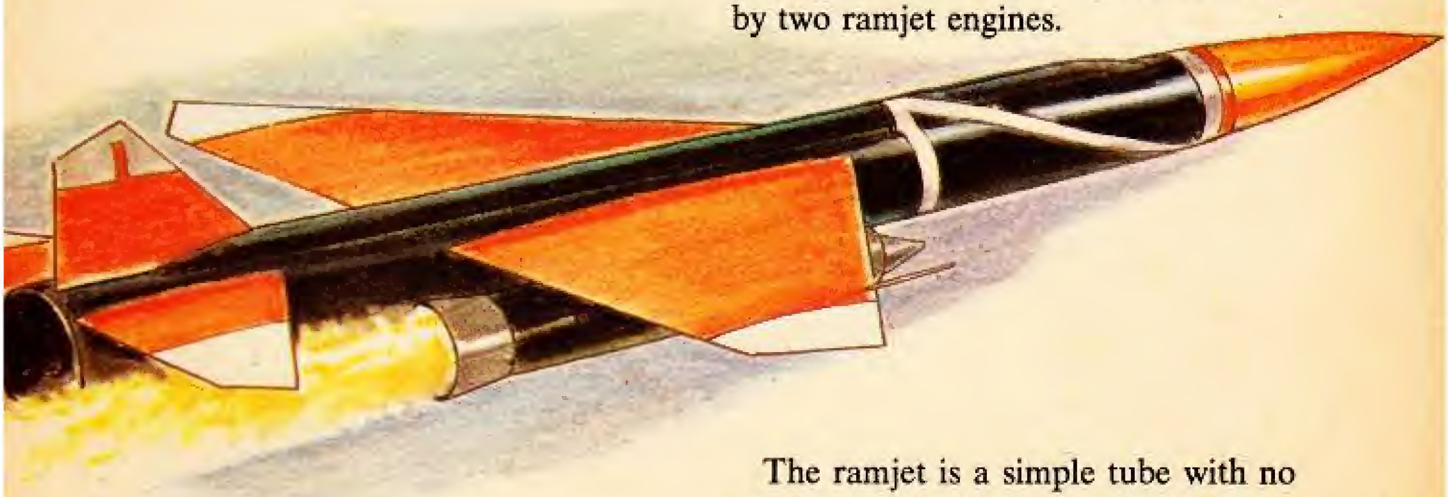
MUST PILOTLESS MISSILES BE ASSISTED OFF THE GROUND?

Until the power plant of any long-range pilotless bomb can reach its full thrust, it must be boosted to flying speed by rockets. When flying speed has been attained, the booster rockets can be dropped.

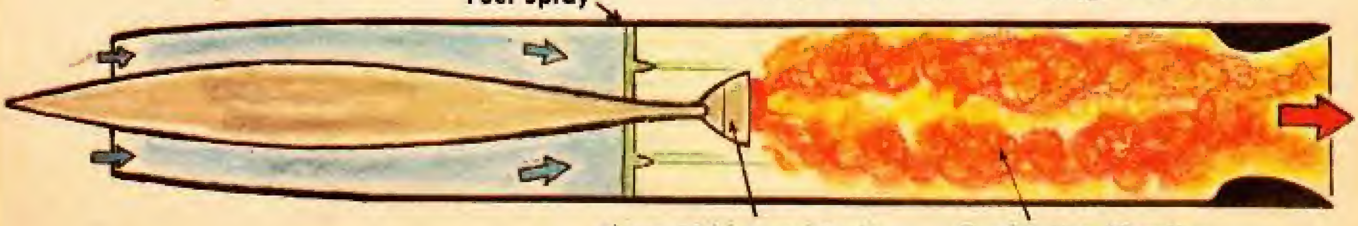


The SNARK, which can fly 5,000 miles and dive to its target from 60,000 feet, is driven by a jet engine after it is hurtled into free flight by two rockets.

On the other hand, the BOMARC, an antiaircraft and antimissile missile, is propelled at twice the speed of sound by two ramjet engines.



The ramjet is a simple tube with no moving parts. However, it does not begin to function until air is driven through it at very high speed. A powerful rocket is fired to bring this about.



The tall structure at the left, used to fuel and service each separate stage of the missile, is rolled back before the firing takes place.

WHAT WAS THE FIRST UNITED STATES SATELLITE PUT INTO ORBIT AROUND THE EARTH?

ON January 31, 1958, a Jupiter-C missile was launched from Cape Canaveral, Florida. An Army Redstone — the first stage — sent it 60 miles up. At 212 miles the ground controller tipped the vehicle to a course parallel with the earth.

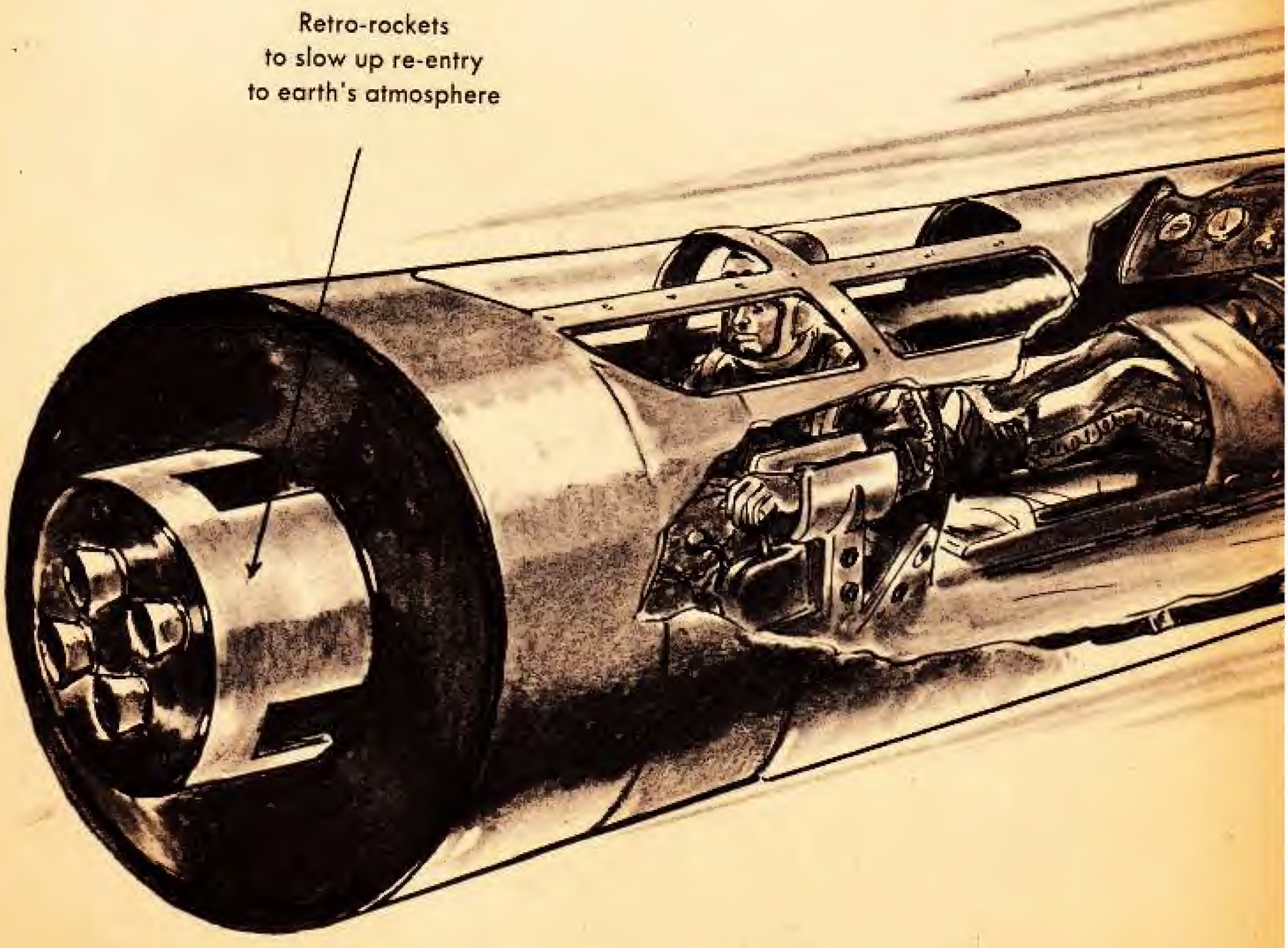
Six seconds later the third-stage rockets of the missile rammed the Explorer I satellite into orbit around the earth.

WHAT IS PROJECT MERCURY?

AMERICA'S PROJECT MERCURY has three objectives: to study man's ability to travel in space; to place a manned satellite in orbit around the earth; and to return the pilot safely to earth.

In 1961, Navy Commander Alan B. Shepard, Jr. and Marine Captain Virgil I. Grissom, in their individual flights in the Mercury capsules *Freedom 7* and *Liberty Bell 7*, made the first manned space flights for the United States. Commander Shepard, America's first astronaut, was launched in a 2,000-pound Mercury capsule that was boosted by a Redstone rocket. The manned craft traveled at a speed of 4,500 mph. It reached an altitude of 115 miles during

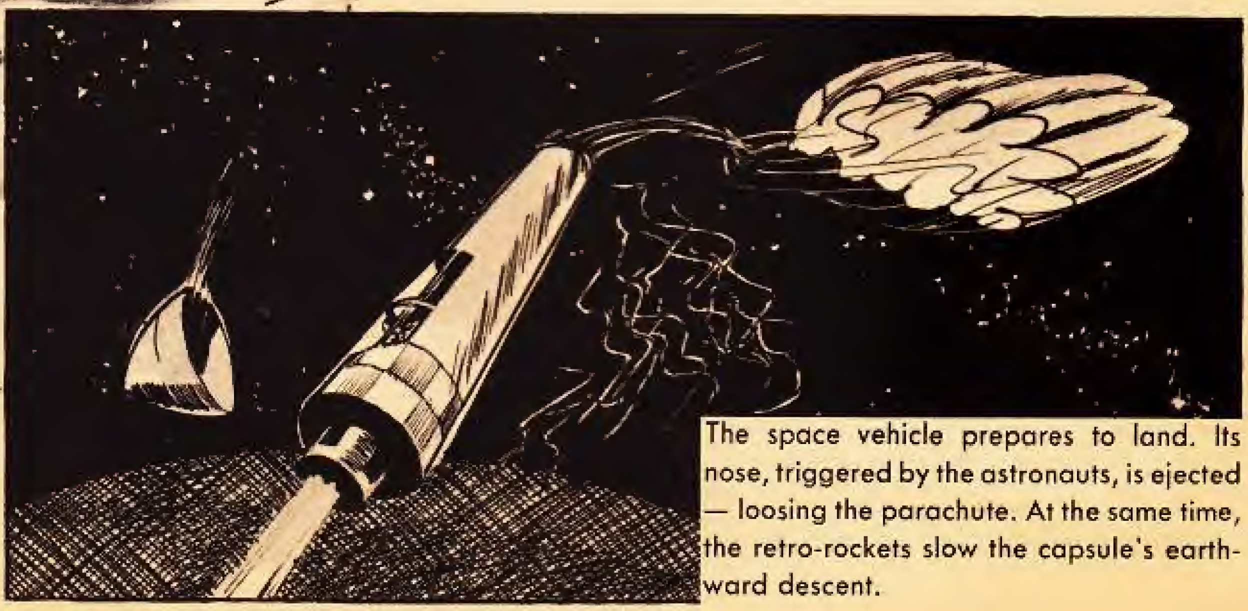
Artist's conception, cutaway view, of a space capsule of a type to follow *Project Mercury*. This larger capsule carries two astronauts.



the 15-minute sub-orbital flight, which occurred on May 5.

The Mercury space capsule, 7 feet in diameter at its base and 10 feet long, holds the pilot. This cone-shaped capsule eventually will be a satellite that is placed in orbit by a rocket. The orbit will be 100 to 150 miles above the earth. Retro-rockets, attached to the capsule, are fired at re-entry time. This slows the capsule so that it can return to earth.

A special shield protects the pilot from the intense heat that is generated when the capsule re-enters the earth's atmosphere.



The space vehicle prepares to land. Its nose, triggered by the astronauts, is ejected — loosing the parachute. At the same time, the retro-rockets slow the capsule's earthward descent.

WHAT DANGERS WILL MAN FACE IN OUTER SPACE?

FUTURE astronauts will encounter many hazards and problems as they travel greater distances into outer space. Some of these hazards have already been investigated by unmanned satellites that have radioed back important information. Some problems, such as the difficulty of re-entry into the earth's atmosphere, have been solved by the Russian and American space flights.

HOW MUST MAN BE PROTECTED IN SPACE VEHICLES?

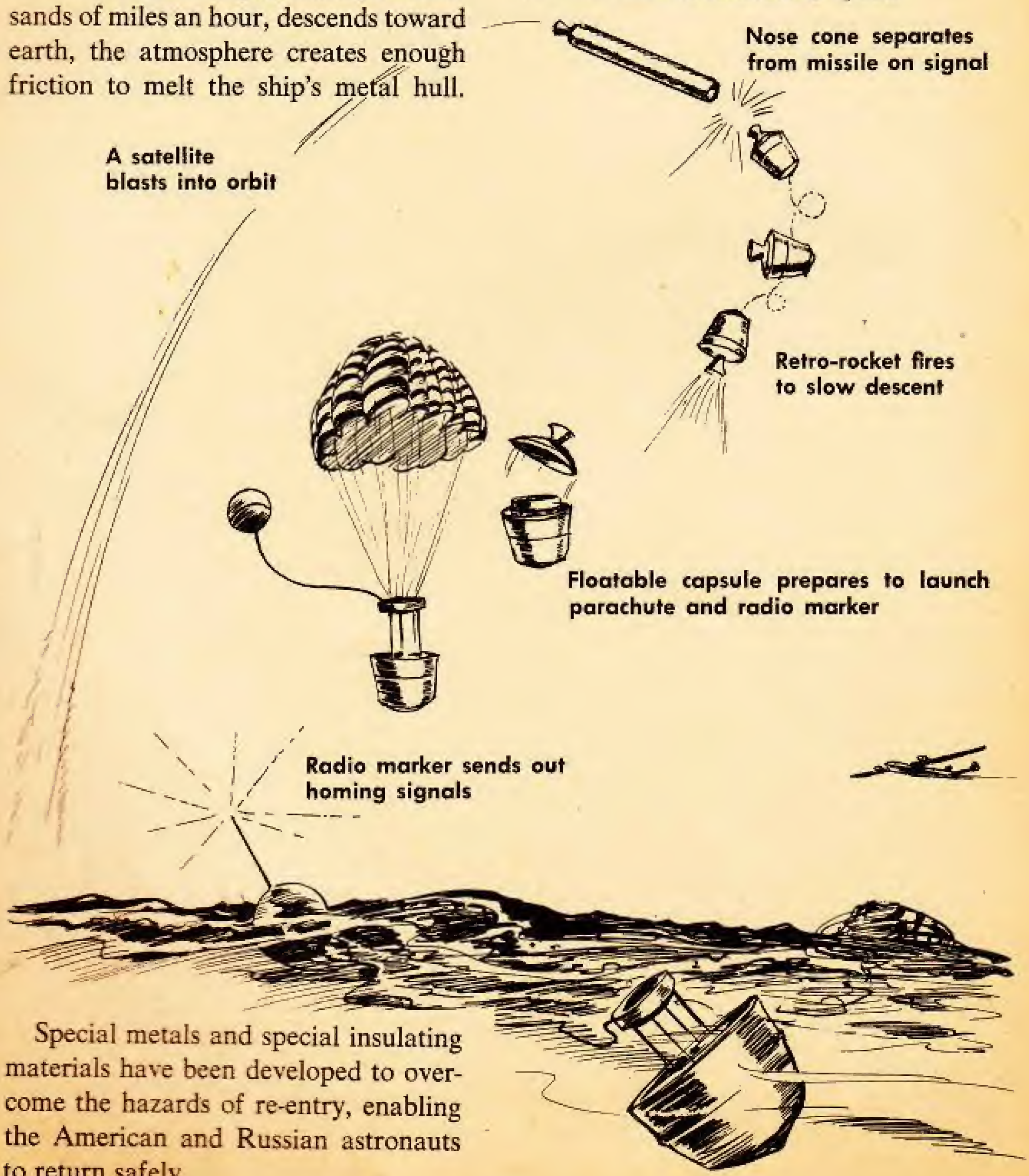
DURING journeys into space, humans must carry with them a sufficient supply of oxygen, food and liquid to last until their return to earth. They must also be protected against searing heat, bitter cold, and shielded against intense radiation known to exist in bands around the earth. Man must be held in place during rapid acceleration and brutal deceleration while leaving and returning to our atmosphere. Once in space, he must learn to cope with the problems of weightlessness and periods of complete inactivity.

THE AIR FORCE MA-I HELMET FOR OUTER SPACE

HOW CAN MAN'S SAFE RETURN TO THE EARTH'S ATMOSPHERE BE SOLVED?

RETURNING to earth from space is as great a problem as leaving for space. For many years, scientists have worked to overcome the difficulties of re-entry.

When a space ship, traveling at thousands of miles an hour, descends toward earth, the atmosphere creates enough friction to melt the ship's metal hull. The *Project Mercury* capsule has a special surface, some of which burns away, thereby protecting the metal beneath. When the returning ship is close to the earth's surface, a parachute opens to slow its descent to landing speed.



Special metals and special insulating materials have been developed to overcome the hazards of re-entry, enabling the American and Russian astronauts to return safely.

WHERE DO WE STAND IN SPACE ACCOMPLISHMENTS?

Even though we are only at the beginning of the exploration of space, a lot has happened since the Russian announcement of October 4, 1957. On that day, the Soviet Union put a 184-pound satellite, called *Sputnik I*, into orbit. It was the first man-made object to circle the earth. A month later, this was followed by another *Sputnik* carrying a live dog.

On January 31, 1959, the United States launched its first earth satellite, and since then has orbited more than 30 instrument-carrying satellites. The Russians have had great success with a small number of large satellites.

On October 7, 1959, the Russian space vehicle *Lunik III* passed the moon and radioed back a photograph of the moon's far side that had never before been seen by man.

Both the United States and the Soviet Union have launched space vehicles toward the sun — vehicles that eventually attained orbits around the sun several million miles from the earth.

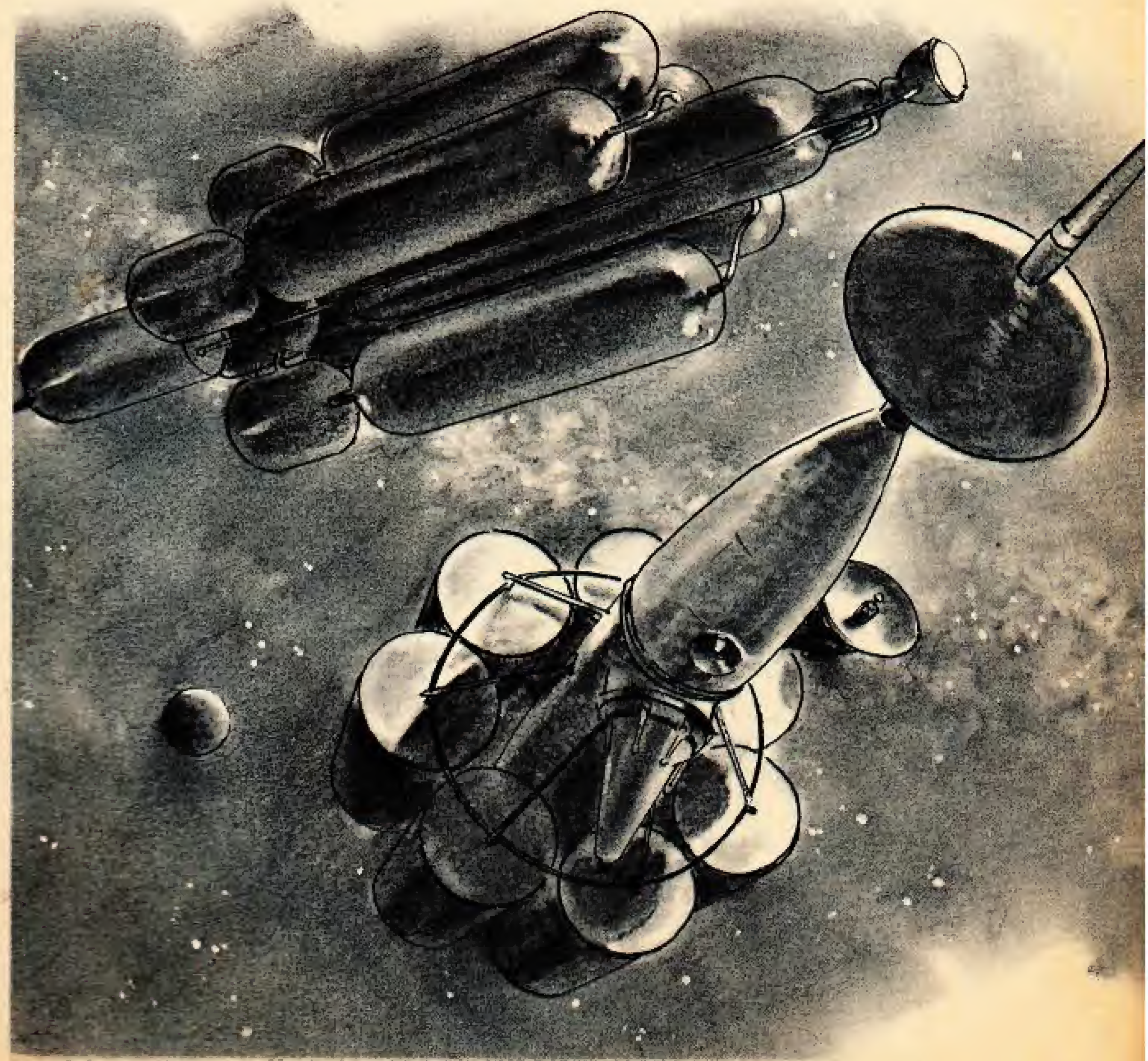
Early in 1961, Russia launched Major Yuri Gagarin into space in a craft that circled the earth. This was followed by America's sub-orbital flights of Commander Shepard and Captain Grissom. Later in the same year, Russia's Major Gherman Titov orbited the earth for more than 24 hours. Man's efforts to increase his knowledge of outer space will result in greater successes in the future.

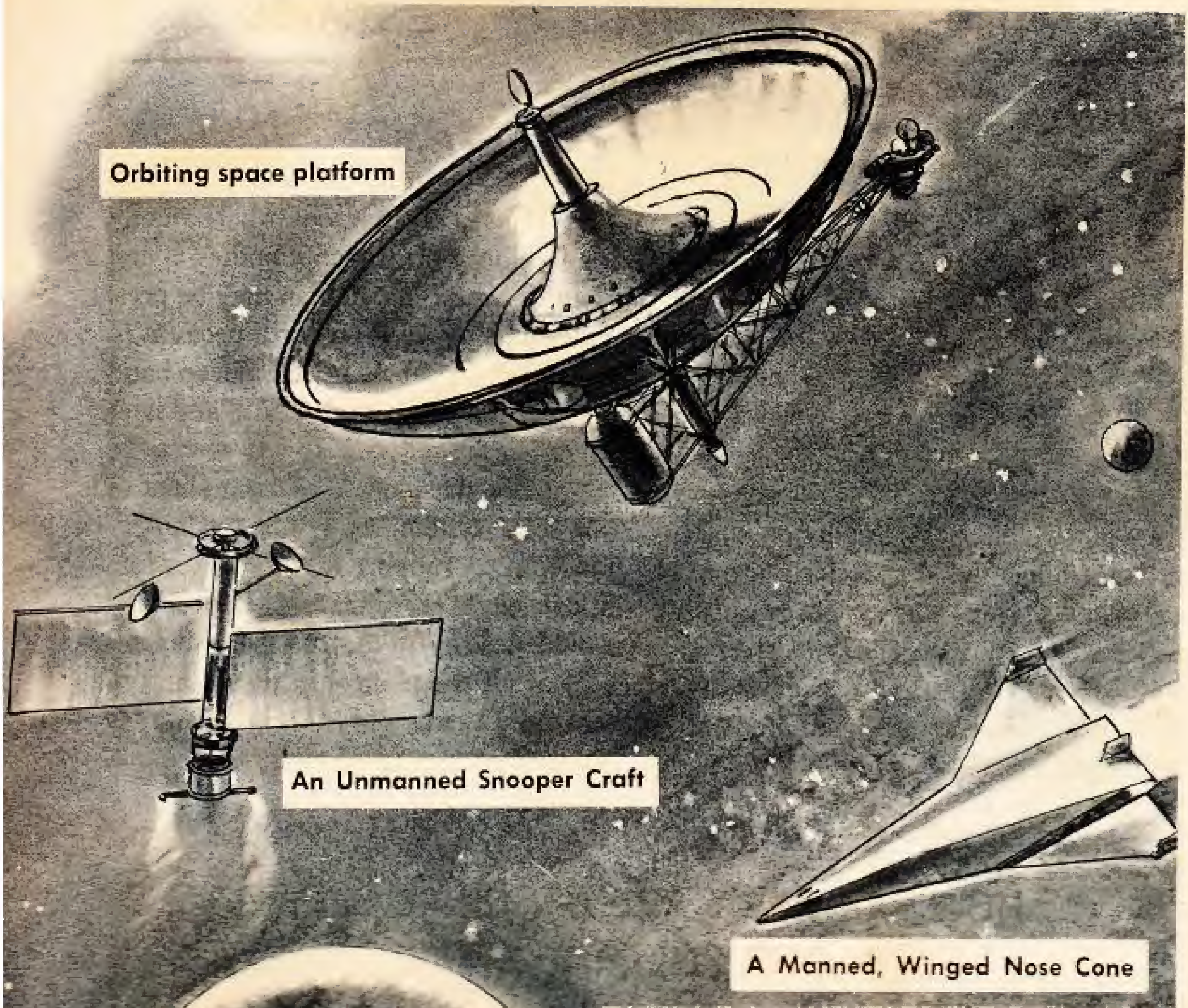
HOW DOES MAN EXPECT TO LIVE IN OUTER SPACE?

SCIENTISTS are convinced that permanent satellites, in orbit around the earth, are necessary as relay stations for radio, television and other forms of communication, for weather observation, global policing or as stopover stations for interplanetary travelers.

Various types of space stations for different uses will be lofted into orbit in separate sections and assembled by workmen in oxygen suits. At regular intervals the satellites will be restocked with provisions, fuel and relief crews sent up from the earth.

Interplanetary Space Stations





Astronomers will welcome the opportunity to continue their studies of the universe from a vantage point outside the earth's atmosphere. They will be equipped with unmanned "snooper craft" to explore outer space and report back by radio. The winged nose cone (at the right) is returning after carrying supplies to a satellite.

WHERE CAN MAN GO WHEN HE LEAVES THE EARTH?

THE EARTH is a small planet among billions of stars and other celestial bodies in a universe that extends beyond man's imagination. A true star is any heavenly body like our sun, which is self-luminous; planets and satellites shine by reflected light. The solar system to which the earth belongs is made up of nine planets which revolve around the sun. Satellites, like the moon which orbits around the earth, circle around the planets. Our solar system is only a tiny part of a larger galaxy of stars — the Milky Way — and astronomers have discovered about a hundred million such galaxies, each of which may contain a hundred thousand planets.

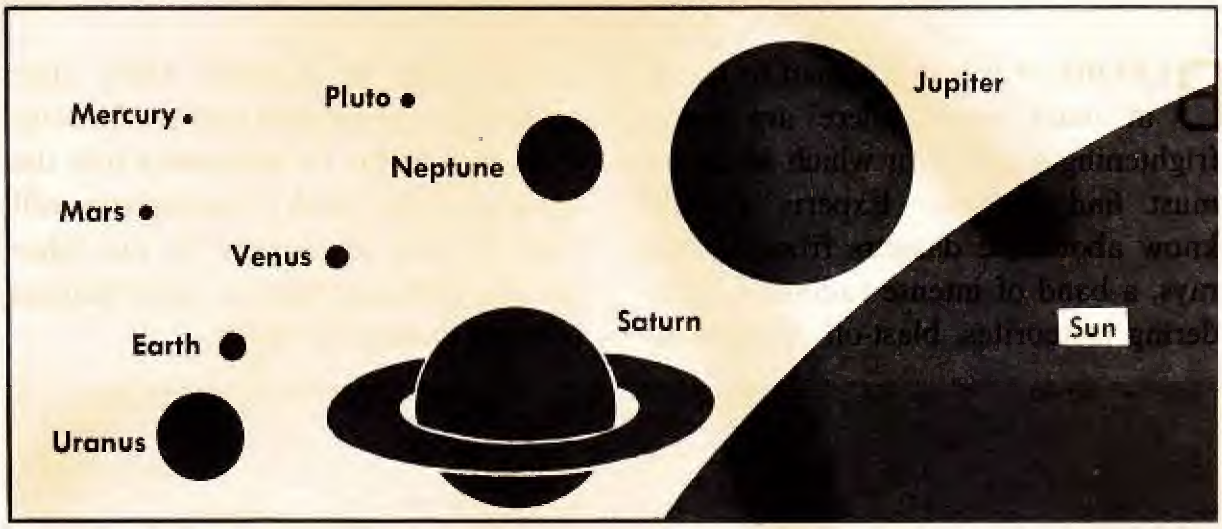
It seems likely that somewhere among these billions of heavenly bodies, living conditions suitable to man may be present. He has thrived on earth because of a combination of elements: a deep band of atmosphere, water to drink, and heat for warmth and cooking.

Among the planets and satellites of our solar system, many are too hot or too cold to support human life, while others give off chemical fumes that would destroy it. Astronomers believe that of all the planets in our solar system, only Venus and Mars have suitable conditions, as well as an atmosphere.

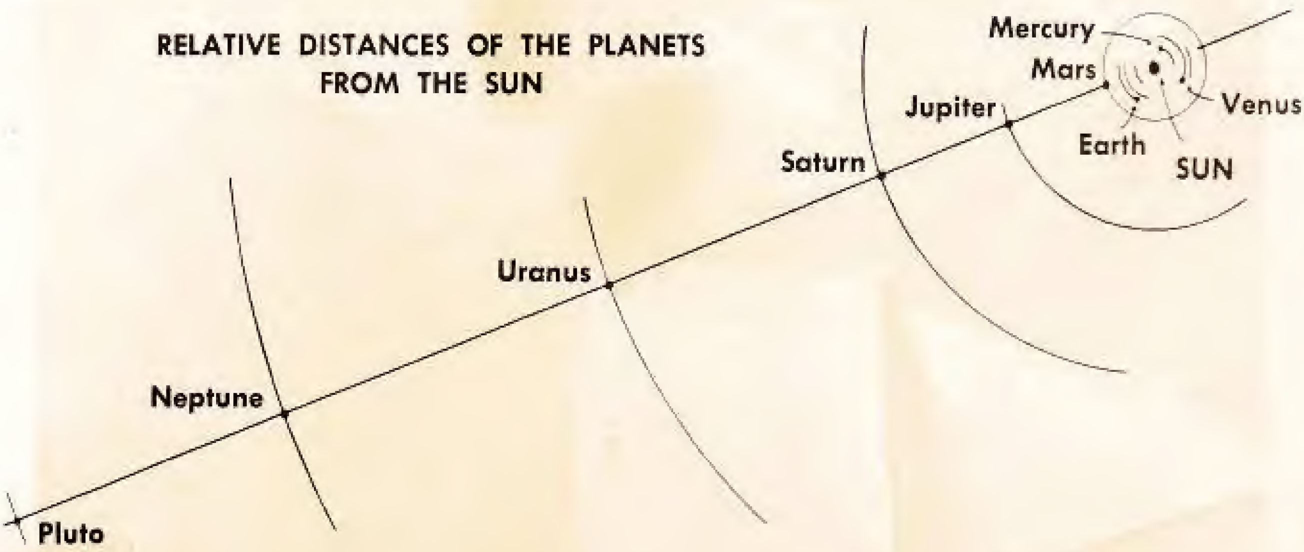
HOW FAR AWAY ARE OTHER PLANETS IN OUR SOLAR SYSTEM?

Planet	Mean Distance from Sun (Millions of Miles)	Length of Year	Period of Rotation	Diameter (Miles)	Gravity at Surface (Earth=1)
Mercury	36	88 days	88 days	3,000	0.27
Venus	67.2	225 days	Unknown	7,600	0.85
Earth	93	365 days	1 day	7,920	1.00
Mars	141.5	687 days	24.6 hours	4,220	0.38
Jupiter	483.3	11.86 years	9.9 hours	89,000	2.64
Saturn	886	29.46 years	10.2 hours	75,000	1.17
Uranus	1,783	84 years	10.7 hours	31,000	0.92
Neptune	2,793	164.8 years	15.8 hours	28,000	1.12
Pluto	3,675	248.4 years	Unknown	6,300	Unknown

RELATIVE SIZES OF THE PLANETS



RELATIVE DISTANCES OF THE PLANETS FROM THE SUN



THE SATELLITES OF THE PLANETS

MARS: 2 satellites. Diameters: 5 and 1 miles. Orbits: 3,700 and 14,500 miles. Circuit time: ½ and 1 ½ days.

JUPITER: 12 satellites. Diameters: 20 to 3,200 miles. Orbits: 112,600 to 14,888,000 miles. Circuit time: ½ to 760 days.

SATURN: 9 satellites. Diameters: 200 to 3,550 miles. Orbits: 115,000 to 8,034,000 miles. Circuit time: 1 to 550 days.

URANUS: 5 satellites. Diameters: 150 to 1,000 miles. Orbits: 80,800 to 364,000 miles. Circuit time: 1 ½ to 13 ½ days.

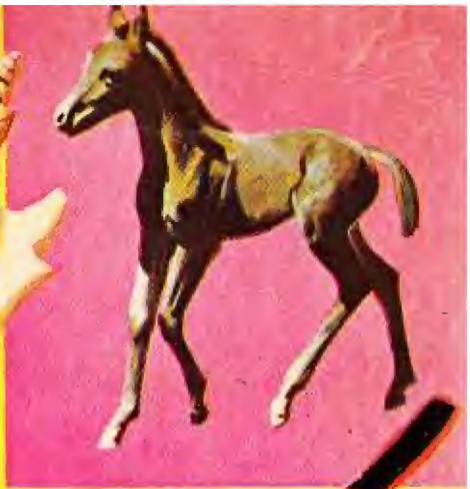
NEPTUNE: 2 satellites. Diameters: 200 and 3,000 miles. Orbits: 220,000 and 5,000,000 miles. Circuit time: 6 and 730 days.

WHEN WILL TRUE SPACE TRAVEL BEGIN?

BEFORE it is safe for man to travel in outer space, there are many frightening hazards for which scientists must find answers. Experts already know about the dangers from cosmic rays, a band of intense radiation, wandering meteorites, blast-off speeds and the problem of re-entry. Only after searching experiments and exploratory dyna-soar flights by volunteers into the fringes of the earth's atmosphere will man be free to journey to the other planets, with stopovers at space stations orbiting around the earth.

In the future, manned space stations orbiting around the earth may be visited regularly by shuttle-craft with supplies and men.

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